

**A PARTICIPATORY SITUATION ANALYSIS OF TANZANIAN
SMALLHOLDER FARMING SYSTEMS:
Identifying points of entry for innovation from the farmer's
perspective**

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List of abbreviations

ASFG	African smallholder farmers group
CSS	Case study sites
etc.	et cetera
e.g.	for example
ha	hectare
HH	Household
kg	Kilogramm
km	Kilometer
l	Liter
mm	Millimeter
Tsh	Tanzanian shilling
UPS	Upgrading strategy
URT	United Republic of Tanzania
VICOBA	Village community bank

1 Introduction

The Tanzanian smallholder agricultural sector generates 95% of national food requirements and income for 75% of rural households (URT, 2009; J. Andersson et al., 2005). Despite the importance of the agricultural sector, 87% of the poor population of Tanzania lives in rural areas, most of them dependent on agriculture (URT, 2005). As in many parts of Africa, Tanzanian smallholder farmers are increasingly confronted with environmental volatilities that enhance the unpredictability and insecurity of regional food supply (J.A. Foley et al. 2011; G. Ziervogel, P.J. Ericksen 2010). Komba and Muchapondwa (2012) point out that especially on the African continent, considerable welfare losses due to climate change can be expected. For Tanzania, trends of increasing temperatures and decreasing rainfall are predicted to continue to rise until 2100 (M. Hulme et al., 2001; J. Paavola, 2008).

Given the challenges of unpredictable climate, increasing food demand and rural poverty, there is a strong need to improve current smallholder agricultural production systems and thereby, to increase production, to increase the system's resilience against future hazards and to improve rural livelihoods. The Trans-SEC project is therefore aiming at *“improving the food situation for the most-vulnerable rural poor population in Tanzania by identifying successful food securing upgrading strategies (UPS) and/or innovations¹ along local and regional food value chains (Gomez et al. 2011; Riisgaard et al. 2010), test and adjust them to site-specific, sustainable settings and tailor these concepts to be disseminated for regional and national outreach”* (F. Graef et al., 2013). The project's objectives demand profound knowledge and understanding of the local context in order to identify and design successful solutions that will meet the needs, capacities and capabilities of the people in focus.

Therefore, this study aims at undertaking an ex-ante participative situation analysis to identify, together with farmers, context specific constraints and opportunities for the later design and uptake of innovations along the food value chain in the CSS (case study sites). To meet this aim, to capture issues of difference and to reveal underlying factors and interrelations, this research follows the more specific objectives of:

1. Identification of the livelihood strategies of different smallholder sub groups and the role of agricultural activities from the farmer's perspective, to reveal target groups for innovations.
2. Identification of regional, gender and socio-economic differences in the access to, endowment and use of available resources from the farmer's perspective, to identify farming strategies of different sub groups of farmers.
3. Identification and participative analysis of context-specific root causes of problems in agriculture and their potential problem chains and inter-linkages for the identified sub groups.

In summary, these points will uncover potential points of entry for innovations from the farmers' perspective, considering regional and socio-economic differences.

¹ For the sake of simplicity and in reference to literature of point 2 this study will continue only with the term “innovation” as a summary for both, UPS and single innovations

An actor oriented approach was chosen because former studies revealed that adoptability of innovations by different types of farmers in different socio-economic circumstances and faced by different contexts tends to be understudied (J.A. Andersson, S. D'Souza, 2014). Current studies build mainly on standard household surveys, although the econometric analysis leaves farmers' own resource allocation strategies, problems perception and underlying context-cause-effect understanding largely unexplored (J.A. Andersson, S. D'Souza, 2014). In order to overcome these weaknesses, this study employs a participatory approach through the use of different communication tools in workshops. This not only helps to get an insight into the contexts people face but also to understand their perception, evaluation and understanding of the situation and what is important to them. It demands for "*handing over the pen*" (R. Chambers, 1994, p. 1254, b) to the actors of the farming system and for giving them a voice and choice, as they should ultimately benefit from the project. The mutual understanding is essential to capture relations and logics that might be important for later decision making on innovation adoption and will help to select and communicate appropriate solutions. Furthermore, it raises awareness, trust and acceptance and initiates a mutual learning process. Here, a situation analysis only stands at the beginning of a longer participative research process. It will assist in structuring, narrowing and describing the problems in focus of the bigger research project. It is not aiming at providing concrete guidance in the sense of which action or innovation should inevitably follow this study.

Chapter two introduces the study by reviewing literature that points out the relevance of the chosen farming systems approach and that answers the questions: 'Which farming system is in focus of this study?', 'Why are innovations demanded by this farming system?', and 'Which general contextual factors according to literature need to be considered when identifying innovations?'. Furthermore, the background debates around employing participative methods, considering their constraints and opportunities are elucidated. Following this point, chapter three presents the methods used for data collection and analysis. Chapter four reveals results in three main parts. Part 4.1 highlights the importance of agriculture by positioning agriculture (crop and livestock production) within the livelihood context and identifies sub groups of farmers based on the livelihood strategies chosen. In Part 4.2 those sub groups are relevant to explain differences in availability of the major resources of production (land, labor and capital). In Part 4.3 and 4.4 the resource situation of different sub groups sets the frame in which crop and livestock activities take place and leads to inter-linked problems along the crop and livestock value chain that participants' analysis revealed. Chapter five discusses and evaluates the results of chapter four, by developing interlinkages between points 4.1 to 4.4 that will help to draw conclusions on potential constraints and opportunities for the uptake of innovations. Furthermore, chapter 5 discusses the methods chosen, considering their opportunities and limitations to meet the aims of this research and suggests options for further research. The last chapters summarize findings and draw a conclusion on the fulfillment of the research aim and objectives.

2 Literature review

This literature review reveals the theoretical background to this study and follows a logical structure in three parts.

The first part describes and defines the overall theoretical approach of this study, namely the transdisciplinary farming systems approach. Given this background, in the second part the farming system in focus of this study shall be defined. For this farming system, most important recent challenges discussed by various authors, shall be outlined, justifying the need for innovations. These innovations need to be designed to be feasible for the farmers. Therefore, in the following various studies are reviewed to summarize, according to literature, common contextual factors that are important for farmers' final innovation uptake. Those factors shall later be taken up again for discussion and comparison with identified site specific factors of the CSS.

The last part of the literature review gives a theoretical insight into the idea, aim and relevance of a participative methodology for this study and reviews constraints and opportunities of this method as identified by former studies.

2.1 The farming systems approach

History

The farming systems approach is a relatively recent approach in agricultural research. In the 1960s the Green Revolution manifested its success story by increasing agricultural production worldwide through the introduction of new high-input demanding technologies. However, in the long run, it became clear that this success did not reach everybody and especially in Sub Saharan Africa technology adoption rates remained low (A. de Jaeger et al, 2001). The capital and productivity oriented top-down research approach did obviously not fit the situation in those countries and did not address the needs of these farmers. Therefore, in the 1980s and 1990s researchers started to express a need for a more holistic and bottom-up research approach in order to understand underlying logics of farming and to find more suitable solutions for development (I. Darnhofer et al, 2012). The approach is referred to in literature as farming systems research.

Idea

Spedding defines a system in general as “*a group of interacting components, operating together for a common purpose, capable of reacting as a whole to external stimuli: it is unaffected directly by its own outputs and has a specified boundary based on the inclusion of all significant feedbacks* (C.R.W. Spedding, 1988, p.18).” He relates this definition to the operational units of agriculture with its entire components (C.R.W. Spedding, 1988). To understand, improve, emulate or choose the best system various investigative ways were taken, from looking at single components up to identifying the most complex component interrelations. The latter form the basis for this study. This study applies a transdisciplinary farming systems approach, which addresses the multifunctionality of farms. Smallholder family farmers act as dual economic agents, combining family and farm interests (B.A. Shiferaw et al., 2009). Their decisions are therefore influenced by inter-related factors both, on the production and consumption

side while as a farming system being as well embedded in a community with its own context (B.A. Shiferaw et al., 2009; I. Darnhofer et al., 2012).

First, one must understand a system before one can influence it; hence, it needs to be recognized with all its components and sub-systems (C.R.W. Spedding, 1988). To visualize the concept of a farming system, an illustration of Dillon (1992) shall be explained.

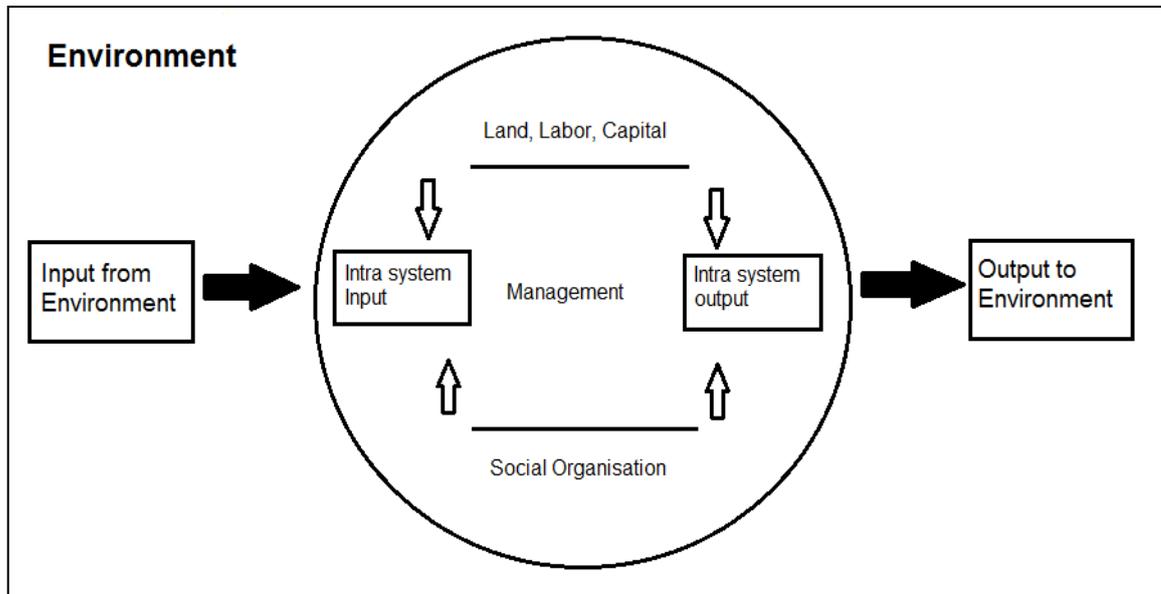


Figure 1 Model of a farm system (J.L. Dillon, 1992)

Dillon (1992) describes the components of a farming system as the physical farm entity including land, labor and the various forms of capital plus the farm management and the farm's social organizational structure and activities. The output of such a system always involves crop and/or livestock products (J.L. Dillon, 1992). Internal to the system are physical resources such as land, labor, buildings, machinery etc. or non-physical resources like know-how and skills or personalities, contacts and formal and informal social organizational structures among members of the farm system (ibid.). The farm system boundary shall therefore include all of these resources and is as such a rather conceptual and open framework. Additionally, the farming system can use inputs from outside the system. External inputs can have various forms, tangible ones such as fertilizers and pesticides but also intangible ones in the form of e.g. knowledge, norms, standards etc. (ibid). The amount of those differs among farming systems, for example subsistence farming systems have a rather low physical in- and outflow (ibid). External and internal inputs can be changed into outputs that can be used or absorbed by the system itself or transferred to the environment (ibid).

Following this description, there are various summarizing definitions of farming systems. A well-known definition of Beets (1990) says:

“A farming system is a unit consisting of a human group (usually a household) and the resources it manages in its environment, involving the direct production of plant and/or animal products. Factors such as climate and weather, land tenure, land quality, and socioeconomic variables are included. It is an ecosystem in which all of the components – land, operators, hired labor, crops and cropping systems, animals

and machinery – are considered together to produce goods to meet the requirements for food, clothing and shelter; or, to exchange for goods to meet part or all of those needs. A farming system is always part of a larger social, economic, cultural, and political environment, which has impact on everything that happens within the system.” (W.C. Beets, 1990, p.5)

There is a need to extend this definition. Apart from the overall target to produce goods as mentioned by Beets (1990), the set of aims of a farming system can be much wider including as well intangible goals such as complying with social and cultural expectations or environmental protection. Often expected benefits go far beyond meeting just requirements of food, clothing and shelter (D.J. Pannell, 1999). Therefore one can say, the target of the farming system is embodied in the use and management of available resources as well as in the output and use of output of this management and is subjective to the farmer of such a system. A farmer may place different values on different outputs (I. Darnhofer et al., 2012). Management choices, objectives and values are shaped by preferences, experience and the interaction with the external environment.

Because farming systems are described as open and interacting with the environment the concept of environment or context that is mentioned by Beets (1990) is especially important for the idea of farming systems. This environment can have multiple levels. Beets (1990) distinguishes into the village community-level, the regional and national level and the international-level (compare figure 2). Impacts in terms of inflows, outflows and interactions of all levels cannot be neglected.

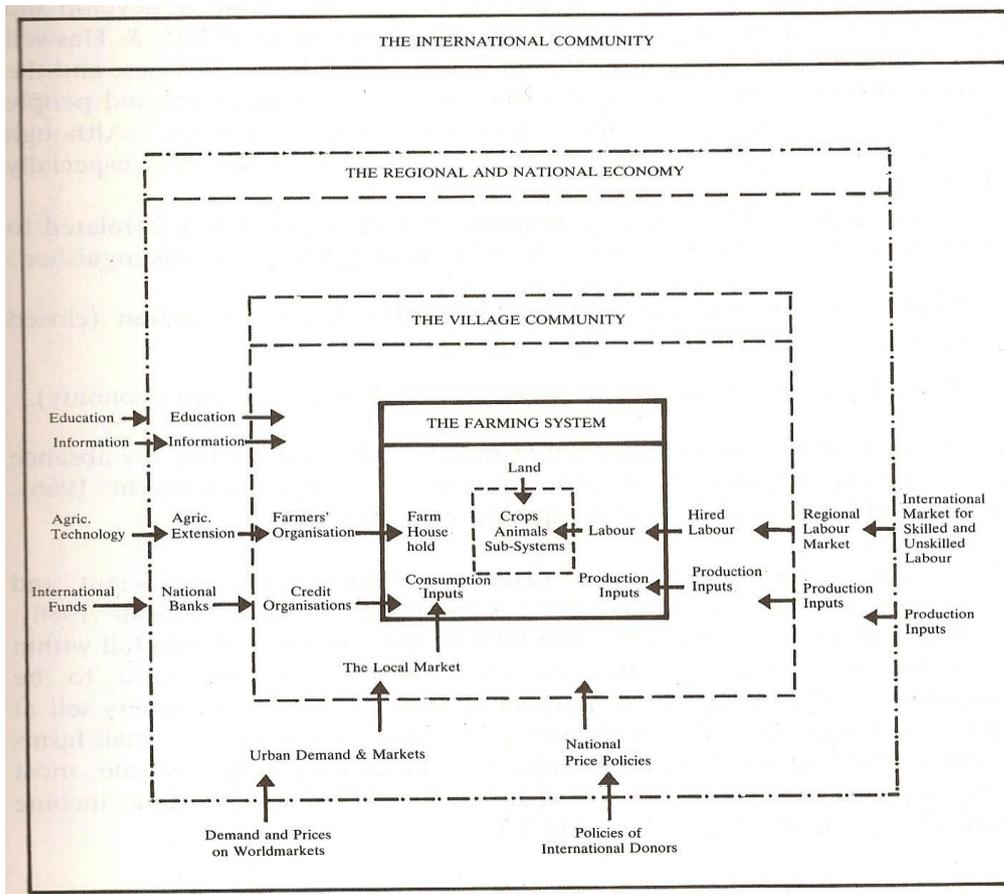


Figure 2 The economic and social circumstances of present day open farming systems, only inflows are shown (W.C. Beets, 1990, p. 83)

However, Beets (1990) definition excludes an aspect which was raised by P.J. Erickson (2008) that is to say that not only the farming system is influenced by its environment but also the farming system itself can influence the environment. Both internal and external inter-relations of farm elements and the environment shape the dynamics of farming systems and understanding those relations is the aim of farming systems research.

According to Darnhofer et al. (2012), when trying to understand a farming system at least three sets of interacting factors need to be investigated: “*the various members of the farm family with their individual preferences, projects and history; the farm with its resources and assets; and the environment which is constituted by social networks, economic opportunities, political incentives and bio-physical context*” (I. Darnhofer et al., 2012, p.3). Important to bear in mind for analysis are the characteristics of a farming system. In a study of B. Kaufmann (2007) these are defined as thermodynamically open (it exchanges energy and matter with the environment), probabilistic (the outputs are not always the same) and dynamic (elements and relations may change in order to adapt to a constantly changing environment and to reach the system’s target).

Apart from the system’s complexity, the last point is most likely the biggest challenge for farming systems research as results constantly need to be re-evaluated with time. The researcher needs to accept that the status quo is fluid and an overall truth cannot be generated at one point in time. Therefore, there is a strong need to see systems research not as a single separate method within a research project but as the overarching project approach over time (O.J.H. Bosch et al., 2007). Researchers of different disciplines combine their skills in a transdisciplinary method. However, scientific knowledge was denounced as insufficient to capture the system’s complexity (I. Darnhofer et al., 2012). Transdisciplinary farming systems research includes strong collaboration with the actors of a system, notably farmers, because they are the knowledgeable people about the real world situation (I. Darnhofer et al., 2012). The ideas of such a participatory approach shall be further explained in Part 2.2 of the literature review.

Relevance

For this study farming systems research was chosen as the preferable pathway, to start the identification of potential points of entry for innovation including, and as suitable to, multiple aspects and factors of a farming system. When introducing innovations, they need to fit into a site-specific context and shall not only solve single component but systemic issues to reach overall systems efficiency and effectiveness² (R. Ackoff, 1999) and thereby foster change.

Therefore, first, it needs to be investigated how farming systems may be different at local level, which can be explained by looking more closely at intra-system resources, (broadly defined as land, labor and capital), in order to see who owns and uses them,

² Efficiency: the lowest volume of inputs per unit of output for each possible combination of inputs, taking into account the prices of the inputs; Effectiveness: the extent to which stated objectives are met (Australian government, productivity commission, 2013)

how use is made out of them and if there are limitations or constraints to their use. In relation to that it shall be investigated how resource use, management decisions and activities are embedded into the local context, to realize in how far the local context is setting constraints and opportunities for the farming system. Thereby the net of various interlinked causes and effects of commonly held farming problems can be revealed. Furthermore, it is highly important to identify those constraints and opportunities that are important to different farmers as well as those factors that influence farmer's decision making on technology adoption as those will be the factors for ultimate innovation success. A situation analysis sets a baseline to understand the dimensions of the system and its most relevant interrelations.

2.2 Low external input systems and resource poor farmers

This chapter shall briefly explain the target farming system of this study and the contemporary circumstances that it has to deal with. This will be relevant to reveal, according to literature, the need for innovations as well as common factors influencing the adoption of innovations. Those will be relevant for the site specific analysis of this study.

2.2.1 Definition

The umbrella term 'smallholder farmer' shall be used in this study, referring to farms with varying sizes but often less than 5 ha that are generally managed by a single family (FAO, 2004; W.C. Beets, 1990). However, since the term is vague it can be further specified in order to identify the target group of this study.

For many of the Sub-Saharan smallholder farms we speak about low external input systems (LEIS). The wording as such already explains that for those systems purchase and use of external inputs is low. External inputs refer to those agricultural inputs and technology that originate outside of the system or local area such as commercial fertilizer or pesticides, tractors or hybrid seeds (U.S. Congress, office of technology assessment, 1988). This can have various reasons. The system may be set under marginal production conditions, for example in remote mountainous areas, on slopes or in semi-arid areas with high temporal and spatial variability of environmental conditions (B. Kaufmann et al., 2013; ASFG, 2010). Furthermore, small farm sizes, poor infrastructure and limited access to markets and governmental services constrain information on and the purchase of external inputs (B. Kaufmann et al., 2013; ASFG, 2010). So overall, those factors can render the use of external agricultural inputs uneconomical and its purchase would increase the production risk (B. Kaufmann et al., 2013).

Therefore, the system is highly dependent on resources internal to the system such as land, labor and capital. Those resources need to be managed continuously to respond to environmental fluctuations because in contrast to high external input systems a manipulation and control of the environment with external inputs is difficult (E.F. Viglizzio, 1994; B. Kaufmann et al., 2013). The system highly depends on renewable resources and biological processes because, as in any agricultural system, inputs shall not be less than outputs in order to have a sustainable system and the only source of inputs to make up for e.g. nutrient losses are the named processes (U.S. Congress,

office of technology assessment, 1988; A. Graves et al., 2004). Thereby, LEIS are complex and site specific, heterogeneous and resemble natural ecosystems much more than industrial systems (E.F. Viglizzio, 1994). In order to be efficient, productive and sustainable, those systems need to buffer or respond to two types of disturbance: the first is the regular seasonal rhythm of climate and prices and the second are unpredictable disturbances like weather events, pest and disease pressures or economic forces (E.F. Viglizzio, 1994). In such systems the farmers have accumulated some of their context specific knowledge already over many generations and due to various experiences. This enables them to adapt to their environment (B. Kaufmann et al., 2013).

In literature, the term 'resource poor farmer' is sometimes used interchangeably with LEIS, although one has to distinguish the forces that lead to the low use of external inputs. First, the term 'resource poverty' does not distinguish between internal or external resources to the system. R. Chambers and B.P. Ghildyal define a resource poor farmer as: "*one whose resources of land, water, labor and capital do not permit a decent and secure family livelihood*" (R. Chambers, B.P. Ghildyal, 1984, p.3). Now there might be farmers whose internal resource endowment may permit to purchase external inputs but due to low infrastructure and limited input markets the availability of external inputs keeps farmers from using them. Smallholder farmers are often excluded from the market because there is little incentive for the private input sector to promote technology in marginal areas and governmental support is often focused on export-oriented agricultural markets and high potential areas (ASFG, 2010). On the other hand, there are those farmers that cannot afford external inputs. The access is limited by resource poverty and internal to the system. Those are the farming systems that are most prevalent in Sub Saharan Africa and that are in focus of this study.

Farmers that work under resource poverty, or limitations, produce primarily for food and subsistence for survival. Around 80% of Africa's farms are smallholder subsistence farms (O. Nagayets, 2005). W.C. Beets points out: "*The needs of the tropical smallholder are urgent; he (sic) needs to produce today because he has to eat today.*" (W.C. Beets, 1990, p.17). As they are highly dependent on each harvest, farmers are not willing to take much risk, which leads in general to low but stable yields. The limited surplus reduces options to react if the overall system gets in disequilibrium with the environment (W.C. Beets, 1990). These general characteristics already need to be kept in mind when opting for solutions to a possible disequilibrium.

2.2.2 Challenges for smallholder farming systems in the 21st Century

After characterizing the LEIS, the following question is arising: 'Why is there actually a need for development researchers to get involved into this system that apparently used to carry itself based on biological processes and local knowledge?'

First, for explanation there are two major variables that need to be looked at more closely, namely the stability and the sustainability of a system. Stability is defining "*the degree to which productivity is free from variability caused by usual fluctuations in environmental variables, such as rainfall*" (W.C. Beets, 1990, p.42; Kepas, 1983). The traditional smallholder systems used to be stable because of behaving rather risk

averse and in their character resembling natural ecosystems. They included a variety of species, which buffered production against common environmental fluctuation (W. C. Beets, 1990). Thereby, stability encouraged the sustainability of the farming systems. Sustainability of the farming systems includes a *“development which meets the present needs of the farm family for food etc. without damaging the resource base, thereby compromising the ability of future generations to produce their needs on the same land, using the same resource base”* (W.C. Beets, 1990, p.16). Because smallholders rely on their farm outputs and alternative sources of income in marginal areas are few, their farming systems need to be highly sustainable and stable in output (ibid.).

With low population density and abundant land, LEIS could be stable and sustainable. But dramatic environmental and socio-economic changes of the 20th century led to a change in parameters and to a disequilibrium between farming systems and their environment (A. Graves et al., 2004). There is common doubt that those systems will continue to function for its stakeholders (A. Graves et al., 2004). At this point, research can assist to help farmers to adapt to this change in parameters, to restore the equilibrium and to get back on track to sustain their production systems and livelihoods.

The change of parameters can be traced back in the environment of farming systems. As revealed by Beets (1990) (compare figure 2), there are several layers of contextual environment. The relevance and impact of some of them, especially those of supra-national scale, might not even be directly obvious to the farmer at local level but do shape farming systems all over the world. Most important overall developments and trends with impact on small holder farms in Africa as identified by literature shall be summarized briefly. This summary is not aiming for completeness as the list of potentially impacting factors is long, referring to a multitude of interrelated political, historical, social and environmental issues. Especially on the national scale incentives or disincentives shape the whole agricultural sector. For the African continent, reserachers stated that poor agricultural performance is also due to political disincentives for a stable agricultural sector, including examples of dismantling processing and transport infrastructure or restricting markets, as much as regional conflicts, weak states in general and their poor governance (S.J. Carr, 2001; S. Haggblade et al., 2010). The following section will reflect on agricultural issues but it needs to be born in mind that they should not be examined in isolation and the idea of encouraging production and production efficiency always also needs to be evaluated in the respective broader political and economic context (S.J. Carr, 2001).

Since the beginning of the 20th century, African traditional farming systems became increasingly open to the world. Thereby, also the context these systems are affected by started to grow far beyond the regional level. The exposure to ‘the outside world’ resulted in various contextual changes for the local smallholder farming system. According to Beets (1990), these changes include population growth, changing consumption patterns and increased desire for material goods, commercialization and changes in prices and market; and a change of technology.

Several researchers, among them Beets (1990), Graves (2004) and Chidumayo (1987), see the population increase of the 20th century as the main cause of changing parameters. Since the beginning 20th century, improved health services led to an

incremental increase in life-expectancy and population. Since the 1960s, African population has been increasing by 2.6% per year, which is much more than in other developing regions like Latin America and Asia (FAO stat, 2008 in S. Haggblade et al., 2019, p.9). With increased population density, pressure on ecosystems increases as well as demand on agricultural productivity. Nevertheless, apart from the African continent also other developing countries face the same situation, which raises the question: 'Why has African agricultural production remained low in comparison to that of Asia for instance?'

As pointed out by Beets (1990), by opening the system, a change of technology and consumption patterns took place. In the beginning of the century, exotic high yielding crops such as cassava, cocoa, sweet potato, groundnuts or maize were introduced to the continent as well as most of all recently available livestock and poultry species (S. Haggblade et al., 2010; S.J. Carr, 2001). Although tremendous productivity gains could be realized, S. Haggblade et al. (2010) criticize that this has taken place in spite of ecological constraints imposed by deteriorated soils, debilitating endemic diseases and limited irrigation potential. Furthermore, new techniques such as planting of perennial crops, clearing of land for ox-plowing and fixed market points were among the reasons why farmers changed their traditional shifting cultivation into more settled, continuous and intensive forms of cultivation (S.J. Carr, 2001). This increased pressure on the environment. The human interference with ecosystems sped up unfavorable processes such as soil erosion and degradation, leading to increased marginalization of smallholder plots and a disequilibrium between the farming system and the environment (W.C. Beets, 1990). Shifting cultivation left plots under long fallow to restore soil fertility but means to restore soil fertility in continuous cultivation were barely available since the switch from one to the other technique took place in short time (S.J. Carr, 2001). The increasing environmental degradation undermines the stability and sustainability of those systems and it remains a big challenge to find suitable restoration solutions, which are feasible for smallholder farmers in Africa (S.J. Carr, 2001).

Environmental degradation becomes intensified by the effects of climate change. Komba and Muchapondwa (2012) pointed out that especially on the African continent considerable welfare losses due to climate change can be expected. During the last 10 years, several droughts in a row could be recorded in different parts of the continent. The impacts of climate change in Africa within various climatic zones are locally specific and hard to predict with an increased frequency of extreme events expected (J.F. Morton, 2007). The exposure to droughts is a big problem for farming systems in those areas as they highly depend on rainfed agriculture (S.J. Carr, 2001; E.L. Molua, 2011). Vulnerability of farming systems to drought is especially high for LEIS due to their small farm sizes, simple techniques, low capitalization and diverse non-climatic stressors such as environmental degradation, conflicts and underdeveloped markets (J.F. Morton, 2007). In fact, low productivity, high transport costs and growing world market liberalization increase the difficulties for African smallholders to compete on the global market (S. Haggblade et al., 2010). Commercialization and changes in prices and markets have restructured the economic incentives for small holders towards an increased dependency on outside markets. Market volatilities with price shocks as in

2007/2008 and 2010/2011 can be a challenge to the productivity of smallholders by mainly affecting the HH consumption in times when people need to spend money on food (IFAD, 2014). In reality, many poor farmers are net-buyers and increased food prices can barely be covered by the agricultural produce generated. A variety of obstacles may keep those farmers from taking advantage of the high prices by producing more or getting more produce to the market (IFAD, 2014).

In summary, current agricultural challenges for smallholder farmers in Africa arise from environmental degradation in combination with climate change. They are shaped by the impacts of population growth and can be accelerated by a multitude of discouraging political and economic stressors. As Morton (2007) points out, the impacts of those challenges are diverse and depend on the intrinsic characteristics of the systems, including their complexity, their location-specificity and their integration of agricultural and non-agricultural livelihood strategies. Morton (2007) sees general positive resilience factors in the family labor efficiency, the livelihood diversity and the stock of local knowledge of the LEIS.

The importance of investigating location specific systems is obvious as it is the only option to understand local interrelations of problems and its causes and effects. There is strong need for improvement of the recent situation towards more sustainability on all levels because the smallholder agricultural sector is generating the major food supply in Sub Saharan African countries and two thirds of the livelihoods of Africa's poor depend on agriculture (S. Haggblade et al., 2010). Improving or at least stabilizing agricultural productivity is a powerful tool to sustain local livelihoods, strengthen food security and potentially increase income among the poor. These are strong arguments to put a focus on research for development. Innovations in agriculture are meaningful tools to adapt to some of the challenges and help to mitigate them.

2.2.3 Factors for innovation adoption in smallholder agriculture

Technology adoption and diffusion is a goal of each innovation project but the complexity of those processes makes the targeting of new technologies difficult (C.M. Moser, C.B. Barrett, 2003). As farming systems theory illustrates, innovations need to fit both, the context and the capabilities of people involved in order to be effective, as there is no 'one-size-fits-all' solution. Hence, understanding which patterns underlie decision making and which problems and opportunities are relevant to the smallholder farmer are core factors, determining which innovations are consequently suitable to be introduced into the smallholder farming system. As Komba and Muchponda (2012) pointed out in relation to the adaptation to climate change, there is a need for each nation to understand the scope and drivers of adaptation especially amongst its smallholder farmers because the sensitivity of each country to potential challenges differs and so do the methods that are appropriate to cope with them.

Final adoption at the level of the individual farmer was defined by G. Feder et al. "as the degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential (G. Feder et al., 1985, p.256)." Hence, it is a dynamic decision process and includes several stages over time that will be related to the functionality of the innovation over time and the according information

the farmer will acquire over time (A.K.A. Ghadim, D.J. Pannell, 1997). The decision to try or not to try an innovation is the first step towards adoption and in focus of this study. Further steps will not be investigated within the scope of this study but rather need to be elucidated during the process of monitoring and evaluation of the project.

A wide range of studies already investigated which patterns underlie technology adoption decisions in various regions. Some of these studies shall be reviewed in this section to identify common factors that provide an overview to identify farming system's interrelations for our study in Tanzania. Recent studies selected for this section investigated adoption patterns for innovations on the smallholder farm level in Sub Saharan Africa that tried to address challenges as identified in part 2.2.2. Specific innovations included conservation agriculture (J.A. Andersson, S. D'Souza, 2014), resource conservation and management practices (A.J. Tenge et al., 2004; B.A. Shiferaw et al., 2009), climate change risk management (E.L. Molua, 2011) and high yielding low external input varieties (C.M. Moser, C.B. Barrett, 2003). However, since factors are site specific and methodology varies there is a high need to compare and evaluate their relevance for this study.

In the late 1990s, D.J. Pannell, together with other authors, published several frequently cited articles dealing with the theory behind patterns of adoption of new technologies. Pannell (1999) defined the preconditions to successfully introduce an innovation to a farmer as follows. The farmer needs to be aware of an innovation, awareness not only in terms of the mere existence of an innovation but rather in terms of the innovation's potentially practical relevance to the farmer (D.J. Panell, 1999). This goes hand in hand with the point that the farmer needs to have the perception that the innovation promotes their objectives (ibid.). This demands for an innovation design and communication that appeals to farmer's needs and demands. Objectives principally involve the profitability of a technical change but can also involve a wide range of considerations such as risk, leisure or environmental protection (ibid). To raise awareness it can be recommendable to include the farmer into the identification and design process, with various ways of participation because this already introduces the learning-process and thereby, may limit uncertainty and skepticism towards an innovation. However, important to bear in mind is that the initial situation is an existing farming system that is operating in some way for the farmer, so it strongly depends on a person's risk aversion in how far they is willing to intervene in this system and try new (ibid). The availability of extension officers as trustworthy agents and source of knowledge can play a key role to increase learning effects (A.K.A. Ghadim, D.J. Pannell, 1997; C.M. Moser, C.B. Baret, 2003; A.J. Tenge et al., 2004). The next point raised by Pannell (1999), is that the farmer needs to perceive an innovation to be feasible and worth trying. To be feasible it has to be possible to embed the trial into ongoing farming processes easily with given resources (D.J. Panell, 1999). The perception of worthiness results from comparing invested costs of time, energy, finance and land of such a trial with the benefits that can be expected (D.J. Panell, 1999).

To achieve the necessary awareness and positive perceptions of farmers, the situation and conditions of the farming system in focus need to be studied carefully. Impacting factors internal to the system and related to resources, farm management and the farmer are various. Factors specific to the individual farmer include the farmers

personal perception, managerial skills and abilities, risk preferences and attitudes towards uncertainty with higher risk aversion being rather unfavorable for innovations (A.K.A. Ghadim, D.J. Panell, 1997). Important are also age and experience of the farmer (A.K.A. Ghadim, D.J. Panell, 1997) as well as educational background (C.M. Moser, C.B. Barrett, 2003; A.J. Tenge et al, 2004). Higher age can be a positive attribute as skills are most likely advanced and there is more understanding for the system and its constraints. Nevertheless, older farmers might have made experiences with other innovations and their perception is shaped accordingly, social stigmas on one or the other type of innovation may intervene as well (A.K.A. Ghadim, D.J. Pannell, 1997; D.J. Pannell, 1999). Important to recognize is also who actually manages the farm and, as Wagura Ndiritu et al. (2014) point out, this is not necessarily the household head, although many studies for simplicity rather collaborate with the household head. The authors of that study revealed differences according to gender of the farm manager (ibid.). In their study, carried out for Burkina Faso, they found out that women in general have less access to and, hence, make less use of new techniques (ibid.). Interesting is also the result of Molua (2011) who found for Cameroon that women preferred low cost management strategies to stabilize their yields and income in the short run rather than increasing earnings (E.L. Molua, 2011). Those studies point out the need for more differentiated research when it comes to the types of farmers involved in a farming system.

Perceptions among farmers differ according to their resource situation. Availability, accessibility and quality of resources are strong factors influencing the demand for innovation. Differences were revealed e.g. in relation to type, size and ownership of land (E.L. Molua, 2011). Constraints were identified due to insecure or inequitable land tenure (G. Feder, D.L. Umali, 1983, D.J. Pannell, 1999), small plots and the inability to enforce property rights (D.J. Pannell, 1999). Important for any decision is, furthermore, the capital situation of the HH. The HH needs to be able and willing to invest some portion of its wealth to venture into an uncertain enterprise, which includes cost of establishing and maintaining the system (A.K.A. Ghadin, D.J. Pannell, 1997, D.J. Pannell, 1999). Farmers draw on their personal discount rate³ to weigh benefits of tomorrow against the investment today (A.K.A. Ghadin, D.J. Pannell, 1997, D.J. Pannell, 1999). The liquidity and hence, personal discount rate, may meanwhile differ among different HH members and according to the season. As well does the labor availability differ in time, even if smallholder farming systems may be perceived as labor abundant (C.M. Moser, C.B. Barrett, 2003; C. Twyman et al., 2004). Off-farm activities may intervene with farming activities (A.J. Tenge et al., 2004). Opportunity costs for the use of labor will be evaluated by the farmer accordingly.

In terms of management the question of whether the innovation is obstructing other farm activities should be raised (D.J. Pannell, 1999). To evaluate opportunity costs in time the questions: 'which activities are most important and when?' and 'when and where are labor peaks?', need to be answered. Tenge et al. (2004) rate the membership of farmers in groups as beneficial for innovation trials. Groups may help to

³ Personal discount rate: high personal discount rate due to poverty is causing future benefits to be less significant than current survival and so current costs for trials may weigh more heavily than future benefits (D.J. Panell, 1999)

overcome resource constraints of an individual and may limit the risk of the individual by reducing individual investments and opportunity costs.

Information on factors external to the system is rather limited. Shiferaw et al. (2009) point out the need to address the externalities of the market, policy and institutions and named for example, the linkage to factor markets and weak organizational arrangements as important issues. Pannell emphasizes, that part of the farmer's decision will be made in relation to governmental policies and institutions in place and to the question of how far these policies and institutions set incentives or constraints for the innovation or for productivity increase in general (D.J. Pannell, 1999). Therefore, the interests and perceptions of those institutions may need to be revealed, as they may not necessarily be in line with what the innovation is promoting. Credit availability, that is affecting liquidity, can be part of institutional arrangements (B.A. Shiferaw et al., 2009). Furthermore, the market sets incentives for production. Andersson and D'Souza (2014) reported e.g. for Southern-African countries that the legume market is limited. This, in combination with a strong household demand for grain staples, undermines crop-rotations with legumes for conservation agriculture (J.A. Andersson, S. D'Souza, 2014). This leads to the last point, namely, that decisions are based on demand, farming sub-cultures and social pressures (D.J. Pannell, 1999). The degree to which these aspects interfere is specific to a country or region and could not be explained by the authors cited.

In general, former studies revealed that adoptability of innovations by different groups of farmers in different socio-economic circumstances and faced by different contexts tends to be understudied (J.A. Andersson, S. D'Souza, 2014). Early studies like those of G. Feder et al. (1985) and D.J. Pannell (1997, 1999), build mainly on econometric analysis, although this leaves farmers' own resource allocation strategies, problems perception and underlying context-cause-effect perception that underpin innovation adoption decisions largely unexplored (J.A. Andersson, S. D'Souza, 2014). G. Feder et al. (1985) therefore also point out, that aside of "pure economic" factors it will be essential to investigate the interactions of various factors related to the social, cultural, and institutional environments, that led to different adoption patterns across regions and countries.

Summarizing the multitude of factors mentioned, one can conclude that there are factors internal to the system (availability and accessibility of resources, farmers characteristics and perception, management), external factors (the institutional, political and economic context) and innovation specific factors that make an innovation more or less worthwhile trying. Additionally, it is important to communicate the appropriateness of an innovation to the farmer in a form that makes sense.

Many recent studies tried to at least identify and name those factors that were of importance for the particular systems under investigation. What is missing is an in-depth analysis of particular aspects of those factors and an assessment to which degree they are relevant. In a very recent study of Andersson and D'Souza (2014), the authors again point out the importance to relate adoption decisions not only to thoughts on the plot-level, agro-ecological circumstances and the innovation itself, but to look at the whole system and to investigate as well the influence of farmer types (as potential users of an innovation) and the socio-economic circumstances in which innovations will

be adopted. The relevance of this demand was underpinned by studies focusing on gender as carried out by Wagura Ndiriti (2014) and Molua (2011).

Drawing a differentiated picture about the broader institutional, political and economic factors with possible affects would go beyond the scope of this study. Rather, this study focuses on the site-specific factors internal to the system for the focal case studies, examining how they are interrelated with the local context. Additionally, it aims at identifying different (socio-economic) categories of farmer.

2.3 The farmer's perspective

The literature review revealed that there is a strong need to understand the farmer's own perspective when trying to find suitable innovations. Approaches to gather farmer perspective differed over time. Many studies mainly build on standard household surveys, although the econometric analysis leaves farmers' own perception of the situation and demands unexplored (J.A. Andersson, S. D'Souza, 2014). A qualitative data collection and especially working in a more participative way with the farmers can contribute to fill this gap. In the following section the value of and necessity for practitioners' knowledge in development research shall be revealed as well as a strategy of participatory work to approach this knowledge.

2.2.1 Practitioners knowledge

The major element of transdisciplinary farming systems research is integration of the farmers' knowledge. Specifically referring to agriculture, it includes the complex practices and decisions made in relation to the agricultural system and is part of the local knowledge of a community or individual that is shaped by the context it is set in (N. Oudwater, A. Martin, 2003). Local knowledge is described by the FAO (2004) as follows: based on experience and tested and transferred over centuries, but nevertheless, it is not static but dynamic and changing by incurring or extending new ideas. As such, it is highly adapted to a local culture and environment and embedded in community practices, relationships and rituals. It may vary among individuals from different social groups according to e.g. age, profession, wealth or ethnicity (N. Oudwater, A. Martin, 2003). The term "local" is less geographically fixed, but rather set within a cultural and ecological context (R. Chambers, 1989).

Practitioners' knowledge shall not be seen as a counterpart to scientific knowledge. Those wordings are rather labels that refer to differing logics and epistemologies and thereby being useful to particular people (A. Agrawal, 2004). Rather than contradicting, they can complement each other. Practitioners are the main actors of the particular farming system; hence, they have an inherent and complex knowledge of the functioning of such a system including technical and cultural knowledge with social and political knowledge and skills (B. Kaufmann et al., 2013; N. Oudwater, A. Martin, 2003). Thereby, they are the ultimate source to gain contextual information about the system in focus. Especially in the face of introducing innovations to a farming system, the value of including practitioners into the research process is mainly based on a coproduction of knowledge (B. Kaufmann et al., 2013). Finding suitable innovations and consequently changing the system is a whole process as such. It is therefore important for farmers to get the possibility to shape this process and thereby, gain new

understandings of the situation that makes a change of action also plausible to them (B. Kaufmann et al., 2013).

This study puts a focus on differentiating the views of men and women. According to Warren (1989) local knowledge systems are by their nature gendered. Men and women can both be practitioners in the farming system. It was revealed in a range of studies that, even if living in the same household, male and female smallholders face very different realities in their daily farming life mainly due to a gender division of labor (S. Feldman, R. Welsh, 1995). They usually occupy different spheres of activity within the system with differences in resource endowment, management and production responsibilities (M. Fernandez, 1994). Croppenstedt et al. (2013) report that in many developing countries women's use of key inputs, services and control over resources is limited leading to lower yields and less engagement in commercial agricultural production. These gendered experiences may have generated different knowledge on different aspects of the farming system. Those sets of knowledge can be related to each other, complementary to each other and may in some cases also overlap. Hence, women and men can have different knowledge of similar things, different knowledge of different things, different ways of organizing knowledge and different ways of preserving and transferring knowledge (R.H.R. Norem et al., 1989; M. Fernandez, 1994). The degree to which these sets overlap depends on the flexibility of the cultural construct "gender" and to which degree specific responsibilities are assigned to men and women (M. Fernandez, 1994). To capture a holistic picture, it is important to give both a voice to vent aspects that are important to them and to realize where there might be relations and contradictions.

However, as pointed out by A. Cornwell (2003) when working with gender-differentiation, this study tries to not see men and women as opposing parties and tries to pay attention to differences within the group of men and the group of women, as they are heterogeneous in themselves and may reflect different views according to power relations and self identification.

2.2.2 The participatory situation analysis

A situation analysis is among the first steps of the innovation process. An ex-ante situation analysis sets the baseline to align research to identified commonly occurring problems and available resources. 'Situation analysis' is a term that is especially used in economics and marketing, where it is the foundation of the strategic planning process. For strategic management, managers need to understand the external and internal environment of their business to plan and select strategies. Internal factors reveal strength and weaknesses of the business, while external factors reveal opportunities and threats for the business that may influence the organization's performance (American Marketing Association, 2014). Although referring to a very different context, the basic idea can be transferred to any project. As explained in the foregoing chapters, also the farming system has an internal and external environment that is shaping its performance. The strategy that needs to be selected in our case refers to the most suitable innovation or set of innovations. How they can fit into the context is in this case as much determined by those factors of strength, weaknesses, opportunities and threats as for the marketing of a business. Since the terms are rather

broad they can include any kind of social, economic, environmental or institutional information.

However, for our study the approach was transferred to a social agricultural science study. It clearly puts an emphasis on a more diverse set of variables since it has a variety of objectives. It is part of the diagnostic phase of any research project to understand and determine the initial situation (A.C.W. Roeleveld, 1996). It follows the principles of participation as this enlarges the shared vision of a problem as well as of being outward looking and learning from and with others about a broader context (ICN, nd.). In a presentation by A. Thomas (2013), the scope of a situation analysis is described as follows: The situation analysis aims at collecting information about situational factors and framework conditions; it shall identify stakeholders and their positions; it shall identify problems including their causes and effects and potentials by detecting and comparing different perceptions. Thereby, the analysis assists in defining the project objectives (ibid.). The information that is collected via the situation analysis can be used as a baseline to later monitor, measure and adapt to change (IUCN, nd.). Moreover, it is the first opportunity to get in contact with the target group, to raise awareness among actors and to mobilize them for further participation in any project (A. Thomas, 2013).

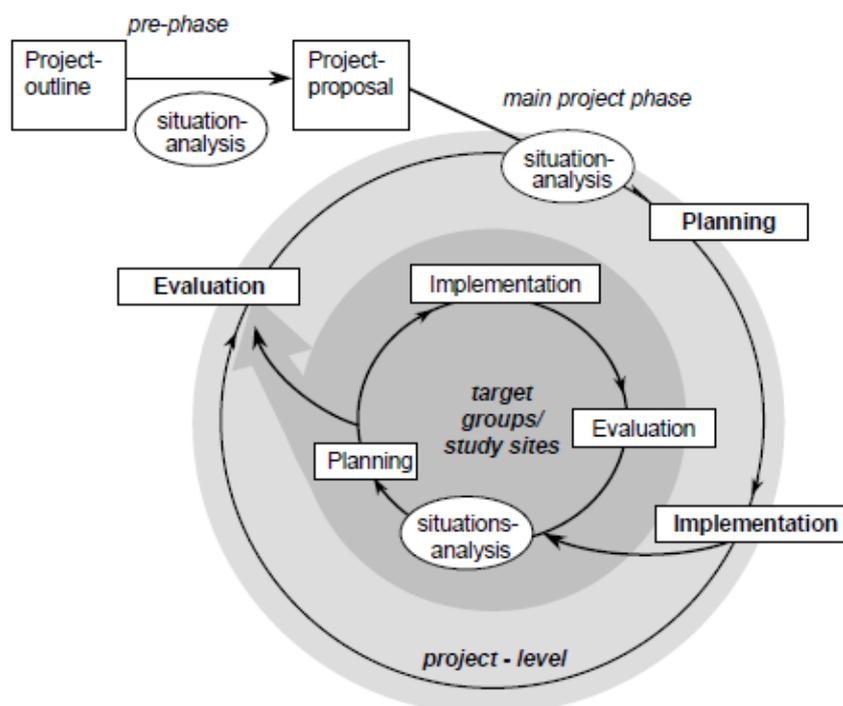


Figure 3 Situation analysis within the project cycle (A. Thomas, 2013)

IUCN recommends the following steps to undertake a situation analysis. First, boundaries of the area to be included shall be identified in a participatory process (IUCN, nd.). In the next step different methods should be used to explore and describe the state and condition of people and the system of investigation (ibid.) It also includes identifying trends, pressures, driving forces and responses and key problems of relevance (ibid.). Furthermore, stakeholders, their interest, influence and importance in the context of the project shall be enlightened (ibid.) Stakeholders are all the people

who are affected by the project and who may gain or lose something as a result of the project (ibid.).

To undertake this analysis, a wide range of methods is available. A. Thomas (2013) summarizes them as follows: Secondary material can be helpful to get familiar with the field situation. In the field the researcher can learn a lot by observation of the study site in general or in certain situations of time or activity. Interviews and questionnaires are a common form to gather quantitative and qualitative data (ibid.). Direct measurements and field experiments can underpin observations with data (ibid.). To understand how components interact and which relations among them exist, valuable information can be captured using participatory rural appraisal or rapid rural appraisal tools (ibid.). In fact, Roeleveld (1996) reports that the methods to address the diagnostic phase in research planning had already started to change in 1996 with a switch from formal to informal surveys with participatory rural appraisals as important components.

2.2.3 Participation and participatory rural appraisal

In order to identify farmers' own resource allocation strategies, their strategies to deal with problems and the underlying web of context-cause-effect perceptions that finally underpin innovation adoption decisions; our study employs a participatory approach.

As Webber and Ison (1994) point out, 'participation' has many different definitions all over the world and there are different levels of power relations in participation. Power relations can include authority, co-operation or autonomy and involve the stages of making decisions for others, with others or individually (L.M. Webber, R.L. Ison, 1994). For group discussions, participation follows the intention to be co-operative and "*a process of creative social involvement by those concerned in defining and fulfilling their needs. It is not a passive taking part in activities designed by others; nor an act of merely consuming the fruits of economic and social activity, it is the taking of initiatives to decide what is to be done and how, and to do it*" (Rhaman, in M. Salas *et al.*, 1989, p. 49).

Participation of practitioners is not only the major factor to understand a situation, but also the first step towards innovation adoption because of the incurred value of trust towards researchers and a mutual learning process. De Jaeger *et al.* (2001) stretch this notion by pointing out that a crucial role for non-adoption of Green Revolution techniques was due to the obliged passive role of farmers, who were involved only in the final stages of technology adoption.

History and Idea

The appropriate method or approach towards those aspects and ideas of participation is referred to in literature as participatory rural appraisal (PRA). Some of its aspects, especially the active role of participants, are already taken up in Rhaman's outline of participation. The bottom-up idea of participatory rural appraisal emerged in the 1990s and focused on: "*[...] methods to enable local people to express, enhance, share and analyze their knowledge of life and conditions [...]*." (R. Chambers, 1994, a, p. 953). It is

an approach to "[...] learn about rural life and conditions from, with and by rural people" (R. Chambers, 1994, a, p. 953).

The idea to encourage participation of local people in research processes was developed in the 1980s and for a long time, was not regarded as a valid appraisal that could generate significant outputs comparable to those of classical research methods. The first approach to make use of local people's knowledge was named rapid rural appraisal (RRA). It addressed the dissatisfaction with former methods in various ways. Researchers recognized various biases when investigating rural settings. First, there was a spatial bias because researchers tended to just make brief rural visits, often in the urban surrounding, thereby neglecting the potentially more meaningful rural peripheries (R. Chambers, 1994, a). The second bias is related to the people consulted; there was often a tendency to rather work together with men than with women and rather rich than poor villagers (ibid.). The third bias is a seasonal one, which means external researchers rather preferred to visit areas during dry and cool times rather than hot and wet seasons (ibid.). The last bias was described as diplomatic since researchers as outsiders never wished to cause offense and thereby, always rather stayed outside of the setting (ibid). Those biases led to the fact that researchers often ignored or were not able to capture the situation of the most poor and most in need. This is one of the origins of opting for more participation. Another essential point was pure efficiency thinking, because researchers realized that RRA was faster and cheaper to be undertaken than classical questionnaire surveys (ibid.). This made sense on the project scale but also meant that decisions and actions for the rural people could be taken much faster. The pioneers of RRA positioned rural people as knowledgeable people of a system under investigation. The growing recognition of this aspect raised the question of how to capture this valuable knowledge best (ibid.). The character of RRA is still more extractive. To encourage more co-operative participation and empowerment of stakeholders, soon participatory rural appraisal developed. A clear distinction of methods being RRA or PRA is difficult. Chambers describes that there is rather a continuum between both, with research approaches tending more in one or the other direction (ibid.). An illustration of this idea is given in table 1.

Nature of process	RRAT			PRA
Mode	Extractive	elicitive	sharing	empowering
Outsiders' role	Investigator			Facilitator
Information owned, analyzed and used by	Outsiders			Local people
Methods used	Mainly RRA plus sometimes PRA			Mainly PRA plus sometimes RRA

Table 1 The RRA-PRA continuum (R. Chambers, 1994, a, p. 959)

local people to researchers, offsetting biases as mentioned before, optimal ignorance to keep the process as intense as necessary but as short as possible and thereby, not raising false expectations, triangulating to validate information with different tools and seeking diversity among people rather than averages (R. Chambers, 1994, b). Special for PRA are principles concerning the outsiders' behavior and attitudes (R. Chambers, 1994, b). Those include the idea of researchers rather being facilitators and "handing

over the pen" (p.1254) to the real world actors, self critical awareness of the researcher concerning own attitudes, personal responsibility on the flexibility of the process rather than relying on manuals and the importance of sharing information (R. Chambers, 1994, b). To this list Conroy is adding the principle of conducting PRA in a relaxed way, meaning to not be and not radiate to be in a hurry and to take appropriate time for the concerns of stakeholders (C. Conroy, 2001). Nevertheless, each PRA conducted needs to be individually evaluated as it is always a result of the professional background, personal and political values of the researcher and the understanding of his or her role. This person will always roll out the PRA in a way that makes sense to him or her given this background (A. Cornwall, G. Pratt, 2003).

Methodology

After explaining the relevant idea and principles of PRA the question arises: 'What is actually taking place in PRA?'

Usually topics are discussed in groups. This is especially important as people face different realities and do not share a common experiential world (L.M. Webber, R.L. Ison, 1994). Those group discussions offer the opportunity to communicate different experiences and thereby find a common understanding. This implies a learning process not only for the researchers, but also for all participants as they are not necessarily aware of their neighbor's reality. Webber and Ison (1994) therefore also elaborate that invitations to such discussions should be open to all potentially interested people. This addresses the PRA philosophy of respect for contributions from every community member (A. Cornwell, 1998). This idea includes the fact that there are differences among farmers within common settings and PRA shall be used with sensitivity towards these issues of difference (A. Cornwell, 2003).

Nevertheless, PRA facilitators were frequently accused by ethnologists to be "blind for the variety of difference" (A. Krummacher, 2004). They point out that rural communities face complex realities and are not homogeneous, neither harmonious (ibid.). They claim that social groups go beyond common grouping and include further non static mixed strategic groups that emerge over time and can be specific to certain purposes over time (ibid.). Krummacher (2004) raises the question if PRA is able to do justice to the diversity of these groups.

Throughout the last years, the sensitivity towards differences in gender in farming contexts became an area of concern. Socio-cultural differences of gender were identified as a fundamental difference in rural settings (A. Krummacher, 2004). As already pointed out in chapter 2.2.1 realities and knowledge of male and female farmers are different. Hence, there is a strong need for gender sensitive approaches in PRA. R. Percy (1999) points out the general compatibility of gender analysis and PRA, as PRA tools are flexible and can be adapted to different situations and people. Cornwell (2003) elaborates that this does not only include separating men from women but actively building especially women's capacity to speak. This can be supported by finding times and locations that are comfortable for the participants (A. Cornwall, 2003). This is a general point in order to overcome the critic on PRA that it disrupts people's lives and livelihoods (A. Cornwall, G. Pratt, 2010). Furthermore, Cornwall (2003) puts emphasis on the fact that women are not a homogenous group and that identification should not take place by essentialising sexual difference but rather by finding "gender

issues” that people can identify with. This aspect is also part of the concern when using PRA and gender analysis together, as collected by Percy (1999). She summarizes that researchers are critical about how to differentiate beyond gender, consider the role of outsiders and avoid raised expectations and potential conflicts (R. Percy, 1999). Attention needs to be paid to those issues when constructing groups and selecting and adjusting tools. Furthermore, Krummacher (2004) raises the question of how to later on integrate back the needs of women and men in dominant overall decision structures, which addresses the question of real-life-empowerment. In fact, it was pointed out by Richards (1995) and Schönhuth (1998) that PRA does not take place independently of local decision making structures and politics since they are constant players in the overall situation and; hence, there is need to recognize local forms of leadership and social relations and rather try to work with than around these factors.

In the early 1990s a number of manuals and handbooks were published, that tried to capture various tools for PRA (R. Chambers, 1994, a). Nevertheless, Chambers points out that they are only partly relevant because one important aspect of PRA for facilitators is also to “*use your own best judgment at any time*” (R. Chambers, 1994, p. 959, a). The approach is flexible and hands over a lot of responsibility to the researcher to adapt to the specific situation.

This approach is especially controversial among researchers. Some claim that “*use your best judgment*” offers the opportunity to creatively explore what PRA is and to adapt to different settings (A. Cornwell, G. Pratt, 2010). But there are different ideas of ‘doing it properly’ and some researchers are concerned that “*use your own best judgment*” leaves room for practices to become sloppy because of not-cross-checking or not using a range of methods with a range of actors to triangulate and to formalize consensus in one way (A. Cornwell, G. Pratt, 2010). Exactly this consensus that those voices are demanding was again criticized to encourage a lack of rigor, by not being sensitive to difference and including a bias towards those “voices screaming loudest” (A. Krummacher, 2004). It is therefore becoming clear that PRA is not “easy” as some people claim, but it rather puts a strong demand on the researcher in terms of communication, facilitation and conflict negotiation skills to include all participants into the dialogue (I. Scoones 1995).

Facilitating tools are various and often build on people’s creativity to engage their analytic skills (A. Cornwall, O. Pratt, 2009). Visual techniques allow participants to express themselves even if they only have low levels of literacy and thereby increase inclusion of all possible stakeholders (R. Percy, 1999). Moreover, they visualize what has already been said and what still needs to be said and thereby form a basis to encourage people to get involved, raise questions and discussion (C. Conroy, 2001). Conroy (2001) summarizes the essential groups of visual techniques into: Timelines and historical profiles, mapping and modeling, ranking and scoring, matrices and diagrams. They address different fields of interest. Visualizing tools are not ‘objective’ methods like questionnaires. Their analysis and interpretation is much more subjective and demands for professionalism and reflection (P. Richards, 1995). It was criticized that often background information of the practitioners about the local situation is limited and that assumptions are drawn from data without a clear sense of how this data was situated (A. Molnar, 1991).

Further, the dynamics of group discussions need to be questioned. Even if organized according to time and location requirements of the participants, group discussions are still a formal and public event for their participants (A. Krummacher, 2004). By including various actors in this event, dialogues will barely be informal, authority-free and rational (A. Krummacher, 2004). The question is also in how far the respective community is familiar with the western democratic principle of free speech (A. Krummacher, 2004). However, the introduction to these principles offers the opportunity to include formerly marginalized groups into a dialogue. But overall, the formal public character influences the way of participation and carries the risk of masking unequal power structures and differences within the community (A. Krummacher, 2004). Attention needs to be paid to different layers of knowledge and which of them may actually be revealed within such a formal public discussion. There is general knowledge, but also secret knowledge or un-sharable knowledge, also non-verbal tacit knowledge incorporated in activities and actions (A. Krummacher, 2004). Krummacher (2004) therefore claims that local knowledge is not a public good but special knowledge is specific to an individual or group that usually only spreads this knowledge, not necessarily verbally, to those that will make use of it and hence, will be able to interpret it.

The social distance of researchers and participants caused by their different backgrounds also impacts the discussion. Even if the researcher tries hard to distance themselves from their professional background and create an equal base, this can only include an attitude change on one side but it does not guarantee for acceptance and openness on the other side. Krummacher (2004) elaborates that in some cases expressed needs and expectations are adapted to the presence of the researcher and the project, and the expected objectives of those. Cornwell and Fleming (1995) also point out that participation is sometimes impacted by what people think the purpose of PRA is, who is there, where it takes place and what the outcome may be. Those aspects need to be kept in mind when analyzing and interpreting information.

Not only group dynamics but also chosen tools impact the outcome of the discussion. Richards raises the question if using a certain tool that includes a predetermined structure like e.g. a calendar, is it not already imposing a too narrow structure on people, which may or may not be plausible to them? Hence, it needs to be understood if actions happen due to structure or are rather a result of practice (P. Richards, 1995, A. Krummacher, 2004). Accordingly, methods may rather need to be adapted to local concepts and need to free themselves from western structures.

This is also an argument against the standardization and mechanization of tools and procedures, which used to be a common critique of PRA. Researchers claimed that PRA emerged to be increasingly used according to handbooks and guides without sensitivity for the setting in which tools are conducted. This may create information but probably rather biased information. Schönhuth (1989) therefore emphasizes that the conduct of PRA needs to be adapted to the situation and that experience does not come from handbooks but from active learning, reflection and experience in the field.

Tenum and Due (2000) claim that tools should be selected and sorted to be useful for and include stakeholders in the three essential comprehensive stages, which are assessment, analysis and action. The idea is that by this broad participation, local

people start to analyze their own situation and will reveal their perception, evaluation and understanding of the situation. As a result, this contributes to a mutual learning process by which the situation can be changed sustainably. Change is not only generated in physical terms but also in a qualitative manner due to the long term implications of a PRA, such as the changing relationships between participants among each other and towards researchers, the feeling of participants to be valued and capacity building among them (L.M. Webber, R.L. Ison, 1994). Researchers, like Schönhuth (1998), Richards (1995), Krummacher (2004) and Cornwell (2003) recognize the benefit of developing a communicative and personal relation to the population and building new relationships with local people.

After its introduction, PRA spread fast. Researchers perceived its elastic possibilities as beneficial for various situations. This led to broad critique on PRA because also its abuse became obvious. Researchers reported about PRA becoming only a label without satisfying content in the way of "*everybody is doing something and is calling it PRA*" (D. Parduhn, 2011). Richards spoke about PRA as a "*flag of necessity*" to get project funding (Richards, 1995; A. Krummacher, 2004). Donors were demanding for more stakeholder participation covered by PRA. But by trying to comply with donor's expectations, some researchers were criticized for rolling out PRA in a 'quick and dirty' way, without sensitivity to local settings and finally missing data validity and representativeness because of limited time invested.

Reflecting on this critique, it is easy to recognize that for PRA people always tended to look at others as a source of a problem: "*to donors, for not being clued up enough to know what to ask for, or so impatient that they wanted things to be done yesterday; to other practitioners for cutting corners and making a fast buck,; to governments for not being serious about public consultation and using PRA as window dressing; to international consultants for making their living from the quick-and-dirty and leaving nationals to pick up the pieces; to NGOs for pushing their own agendas [...]*" (A. Cornwall, G. Pratt, 2010, p.270). Thereby and as illustrated in the previous sections, negative critique is various and mainly evolved from the question of what is actually the right way of conducting a PRA (A. Cornwall, G. Pratt. 2010). Concrete solutions to the points of critique are barely given by literature. This is due to the point that, in fact, PRA is highly site specific and there is simply no one-fits all good-practice solution because real life situations would always demand compromises (A. Cornwall, G. Pratt, 2003). These elastic possibilities are its challenge and opportunity at the same time. It depends on the attitude of each researcher or team of researchers how to best make use of PRA. Therefore, if researchers critically reflect on their own work, accept and incorporate the mentioned critique and work together, exchange experience and thereby develop, PRA work can be improved and can get at least closer to the principles promotes. This would also grant PRA more credibility in the public debate.

Relevance

The relevance for more participative research for Tanzania was stressed by A.E. Temu and J.M. Due (2000). They compared the data of a classical sample survey with participatory appraisal approaches and realized the benefits of time savings, lower cost and the generation of high quality information and more stakeholder involvement and

empowerment (A.E. Temu, J.M. Due, 2000). They include the point that by that time few participatory research had been undertaken in Tanzania and therefore, the involvement and introduction needs to take care progressively with both sides, the researchers' and the participants' one (A.E. Temu, J.M. Due, 2000).

Summing up, Chambers pointed out that PRA "*shifts the normal balance from closed to open, from individual to group, from verbal to visual, and from measuring to comparing* (R. Chambers, 1997, p.104)." For this study this allows for learning from and with the farmers about their perspective and perception on gender and socio-economic differences in the use, endowment and value of available resources, to identify different types of farmers as perceived by the village people themselves, to understand the context-specific root causes of problems and their problem chains and finally to identify together constraints and opportunities for the uptake of innovations. The purpose of this participatory situation analysis is hence, to gather a collection of information, which will assist in structuring, narrowing and describing the problem in focus of the research project, namely to identify successful food securing upgrading strategies and/or innovations along local and regional food value chains (F. Graef et al., 2013). The participatory approach of this early study initiates the mutual learning process and helps in raising first awareness for the project. It opens gaps that may demand for further investigation. It is not aiming at providing precise and complete guidance in the sense of which action or innovation exactly should inevitably follow this collection.

3.1 Study area

3.1.1 Tanzania

The United Republic of Tanzania is the largest country in eastern Africa in terms of land and population. Tanzania is a fast growing society. The population from the 1960s had almost tripled to 44.9 million inhabitants in 2012 with an average household size of 4.8 persons (URT, 2012). 33.1 million of the population are living in rural areas. Among them 7.7 million men and 9.3 million women are active in agriculture (FAO Stat, 2014).

The country is divided into 30 administrative regions, which are again divided into districts, divisions, wards and villages. The villages, as they exist today, are the result of the 'villagization' program. The program was implemented by the ruling communist party under president Nyerere in the 1960s. The idea was to facilitate the use of modern agricultural techniques in collective production, as well as to improve access to drinking water, health stations and other services for the previously dispersed rural HH (G. Thiele, 1986). In the 1960s, the program started as a voluntary movement of HH into villages but in the 1970s the state decreed that all rural HH should move to designated settlements (G. Thiele, 1986). Results of the 'villagization' program have been discussed widely and critically on their positive and negative socio-economic and environmental effects. But the communist agriculture policy went beyond the 'villagization' program and included, furthermore, the control of agricultural prices and markets, and the nationalization of agricultural estates, industries and the service sector (F. Ellis, 2003). Liberalization of the economy began in 1985 and helped to increase the nation's overall GDP (P. Rowhani et al., 2011). Nevertheless, Ellis (2003)

is criticizing that the developing private sector is strongly intertwined with the public sector and is developing as kind of a “by-product” of the strong public sector. Only in 2000 the Tanzanian government divested the last parastatal organizations, of which many involved the dismantling of previous crop marketing bodies (F. Ellis, 2003). Hence, the agricultural sector was strongly affected by the political changes of the last 30 years.

Nowadays, the agricultural sector is accounting for half of the national GDP and 60% of the merchandised exports (URT, 2005). Thus, it is the biggest economic sector in the country. It has a recent average growth rate of 4.8% (URT, 2005). Only 15% of the total arable land is used for crop production (P. Rowhani et al., 2011). The majority of the Tanzanian farmers are small holders of low external input systems. Most farmers depend on rain fed agriculture (C. Komba, E. Muchapondwa, 2012). Furthermore, the Poverty and Human Development Report of 2007 (URT, 2007) revealed that 87% of the Tanzanian farmers interviewed were not using chemical fertilizers; 77% were not using improved seeds and 72% were not using pesticides, herbicides or insecticides. Farmers justified that with the high cost of agricultural inputs and services (URT, 2007). Nationally, maize production is the most important agricultural activity, constituting 31% of total food production (E.E. Msuya et al., 2008). Maize is followed by other major cereals like rice, sorghum, millet and wheat (J. Thurlow, P. Wobst, 2003). The major livestock kept are chicken and dairy cows (FAO Stat, 2014). Farming systems differ a lot between regions in adaptation to the local settings and include various crop-farming systems as well as crop-livestock-mixed systems and pastoralists (USAID, 2008).

Local conditions are highly variable due to the complex landscape of Tanzania (P. Rowhani et al., 2011). There is substantial spatial variability in climate with a tropical climate at the coast, semi-moist lake regions and the temperate highlands (P. Rowhani et al., 2011). Seasonal rainfall is driven by the Intertropical Convergence Zone and occurs mainly between October to May with spatial variation (C. Sweeney et al., 2010). Furthermore, the climate is affected by large scale climatic events such as the El Niño southern oscillation and the North Atlantic oscillation (P. Rowhani et al., 2011). UNDP researcher Sweeney (2010) stated that observations of rainfall show statistically significant overall decreasing trends in annual rainfall. During the last decade it has decreased at an average rate of 2.8 mm per month (C. Sweeney et al., 2010). Additionally, temperature is increasing and is predicted to rise two to four degrees by 2100 (M. Hulme et al., 2001; J. Paavola, 2008). For the interior regions this trend is expected to rise even more, with a prolonging and warmer dry season, a reduction of precipitation of 20% until 2100 and an increasing risk of drought (M. Hulme et al., 2001; J. Paavola, 2008). Hence, as in many parts of Africa, Tanzania is increasingly confronted with climate change that may enhance the unpredictability and insecurity of regional food supply (C. Arndt et al., 2012; P. Rowhani et al., 2011).

The smallholder agriculture sector is recently generating 95% of the national food requirements (URT, 2009). It is generating the income for 75% of the rural HH (J. Andersson et al., 2005). Despite its importance, the rural area remains the region with the highest poverty rate. 87% of the poor population of Tanzania lives in rural areas, most of them dependent on agriculture (URT, 2005). A report of USAID (2008) is

pointing out that few poor farming HH are able to generate the food for the whole year. Children from rural HH are generally more malnourished than their urban counterparts (URT, 2005). Access to clean drinking water is also limited. 47% of the rural HH are still using unprotected sources of drinking water (URT, 2005). The mentioned income poverty and food insecurity are a threat to rural livelihoods and demand an improvement of the farming situation.

The United Republic of Tanzania (2005) recognized already a list of general constraints to agricultural productivity that include: Low productivity of resources, underdeveloped irrigation potential, limited access to financial services, inadequate agricultural technical support services, erosion and environmental degradation, weak producers' organizations, depressed prices for primary commodities in global markets, insecurity with respect to property rights to land and poor rural infrastructure hindering effective rural-urban linkages. In fact, infrastructure in rural areas remains underdeveloped. Most rural areas lack proper road networks, quality transport, communication and energy services (URT, 2005). This is making rural areas increasingly less attractive. Comparable to many other developing countries, a trend towards urbanization is also recognizable in Tanzania with especially many young people looking for their opportunities in the cities. Rural-urban migration as well as the fast growing population is likely to increase future food demand.

Climate change, rural poverty and food insecurity constitute the need to enhance farming practices and increase farmer's self-sufficiency. Both farmer's needs as well as nationwide demands are justifying the need for suitable innovations.

Field data collection took place in four representative case study sites (CSS) in the Dodoma and Morogoro regions of Tanzania.⁴ They are indicated in the map in figure 4.

⁴ Villages were already selected beforehand by project partners according to the following criteria:

- Main selection criteria for regions: two climate types:
 - semi-arid Dodoma (350-500mm)
 - semi-humid Morogoro region (600-800mm)
 - clear distinction between the regions
- Other criteria within the regions:
 - rather similar climate (must) +/- 80mm,
 - weak and good market access
 - rainfed crop–livestock systems oriented, not too strongly paddy rice oriented (< 20% rice)
 - village size: approx. 800-1500 households
- Others: MVIWATA villages (if possible), no other large projects intervening, stunting cases, logistics and infrastructure, different wards, land availability, facilities, capital, soil types, and population density etc.

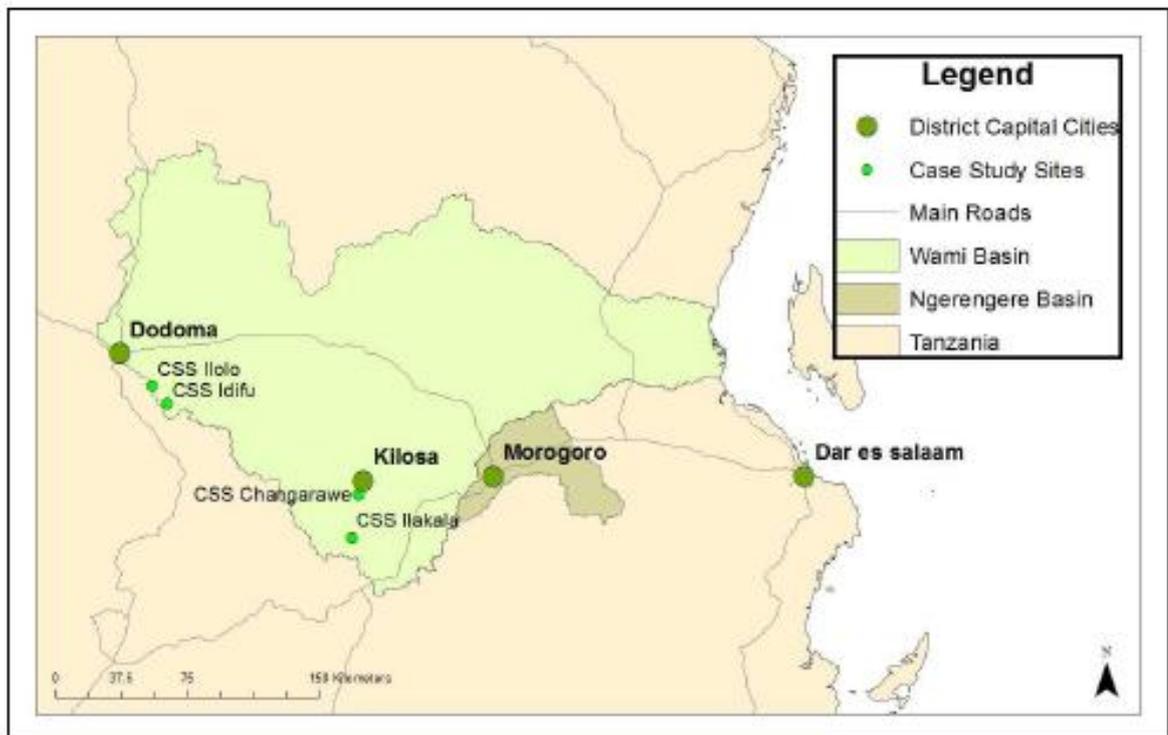


Figure 4 Map of CSS (source: Pendo Schäfer, M., 2013)

In table 2 features of Dodoma and Morogoro are compared against each other. More specific information on the districts and CSS will be provided in each section.

Table 2 Features of Dodoma, Morogoro and the CSS

	Dodoma		Morogoro	
Location	Central plateau		200km to the West of Dar es Salaam	
Population	2 million		2.218 million	
Literacy	62% women 72.8% men		73.3% women 85.1% men	
Life expectancy at birth	49 years (women)	51 years (men)	52 years (both)	
HH in agriculture	360 000		300 000	
Climate	Semi arid		Semi humid	
Vegetation	Seasonal xeric shrubland, scattered succulent trees		Woodlands, bushed shrubland, grasses	
Food crops	Sorghum, Millet		Maize	
Cash crops	Groundnut, sunflower		Simsim	
Livestock	21% of HH keep cattle		6% of HH keep cattle	
Animal power	14% of HH		3% of HH	
	Idifu	Ilo	Ilakala	Changarawe
Market access	Low	High	Low	High
Closest economic center	Mvumi, ca. 20 min by motorcycle	Mvumi, ca. 10 minutes by car	Kilosa or Mikumi, both ca. 1h by car	Kilosa, ca. 10 minutes by car
Specific features	Importance of livestock, fertile wetland area		Proximity to Mikumi National Park	Land scarcity, most developed infrastructure

3.1.2 Dodoma

Dodoma is among the poorest regions of Tanzania. In 2010 it was positioned as 21 under the national based wealth index of 22.2 (URT, 2012). It has a population of around 2 million people but is experiencing a high level of outmigration (ibid.). Literacy rate especially among women is low with 62% of women and 72.8% of men being able to read and write (ibid.). Life expectancy at birth for men and women is different as well, with 49 years for women and 51 years for men (Knoema, 2006).

Located in the central plateau, Dodoma's climate is semi-arid with 350 to 500 mm precipitation per year. The short wet season lasts from December to April. High temporal and spatial rainfall variability constrains the crop production. Rainfall is especially unpredictable in January when most crops are sown (URT, 2012). Vegetation is seasonal xeric shrubland. Scattered succulent trees, including baobabs, shape the landscape. 35% of the area is potentially arable land (ibid.).

Of the 360 000 HH involved in agriculture 71% are working in crop-farming systems and 29% are involved in crop farming and livestock keeping (URT, 2012). Dodoma is populated by the Gogo tribe; traditional livestock keepers that formerly lived in dispersed homesteads (A.P. McCauley et al., 1992). They used to attribute the family's wealth to the size of the cattle herd. With the 'villagization' program after independence

in the 1970s, the livestock keepers were relocated into villages to facilitate the delivery of governmental services (A. P. McCauley et al., 1992). Nowadays, the Gogo tribe is working in a mixed crop-livestock farming system. Most important crops grown here are sorghum and millet varieties as food crops and groundnut and sunflower as cash crops. Overall, cereals constitute 71% of the crops grown in Dodoma (URT, 2012). Root crops, tubers, fruits and vegetables are barely found (0.4%) (URT, 2012).

Appreciation of livestock remains high. In the whole region 21% of HH rear cattle and 14% make use of animal power (URT, 2012). Only since 2003, cattle stocks have increased again (URT, 2012). Before, they were depleted and restricted by the soil conservation program HADO for several years (Dodoma region soil conservation project). It started in 1973 and was aiming at addressing land degradation in a rapidly deteriorating area. Measures of the program included, among others, closure of the most severely affected areas of more than 1200km² (Kondoa closed area) for grazing livestock. Therefore more than 85,000 cattle, goats, sheep and donkeys were cast out (B.R. Ogle, 2001). The herds were moved to the surrounding plains but mortality was high, around 50% or more, causing hardship to the livestock keepers (B.R. Ogle, 2001). Due to these severe effects in 1989 some form of reintroduction of livestock was allowed but still containing many restrictions on amount and grazing system (B.R. Ogle, 2001).

3.1.2.1 Chamwino

Dodoma CSS are located in the Chamwino district, which includes 77 villages in total. The district has the lowest literacy rate in the region (URT, 2012). About 90% of the active working population in Chamwino is employed by the agricultural sector (F. Graef et al., 2013).

Of the 805.600ha, 563.920ha are suitable for agricultural production and 246.821ha are already used for crop production (F. Graef et al., 2013). On average, one HH cultivates 2.4ha of land (URT, 2012). Redish-brown loamy sands are predominant but grey clay soils can be found in depressions (F. Graef et al., 2013).

The district contributes a big portion of the total regional production of sorghum, maize, and cassava. Grapes were as well introduced to the region as high value crop for the wine industry, but there remains a lack of certificates and standards to effectively merge the two sectors (K. Mutabazi, 2013). 79% of the HH in the district have access to a crop extension service (URT, 2012).

In the district, 14 monthly primary livestock markets can be found, one of them in Mvumi mission.

In Chamwino, selected CSS are Idifu and Ilolo. The researcher spent more time in Idifu than in Ilolo because Idifu is more remote, has less developed infrastructure (road construction and network, telecommunication, public transport) and less market access than Ilolo.

Idifu

Idifu is principally divided into a central village, which is separated from the outer village parts by a wetland area. During the rainy season, this area is flooded. It has 14 sub villages. Households in Idifu are very scattered, even inside the central part. To arrive in Mvumi mission, the district's economic center, it takes around 20 minutes by motorcycle. In table 3 characteristic and distinguishing features of Idifu are listed. Infrastructure in Idifu is less developed than in other CSS.

Table 3 Idifu: characteristic village features

Category	Features
Natural	Semi-arid climate
Natural	Wetland
Physical	4 milling machines
Physical	Oxen and oxen carts for rent
Physical	Distance to Mvumi
Physical	Partial mobile phone network
Physical	Medical station
Financial	TASAF Aid
Social	Gogo people
Social	Christians

(source: K.D. Mutabazi, 2013; own observation, Feedback seminar, Idifu, 22.04.2014)

Ilolo

Ilolo is located close to the rural town Mvumi mission. For villagers it is possible to either walk or arrive by bicycle to the town. The main street for local transport, connecting Dodoma town with Mvumi mission, is passing through Ilolo.

Ilolo has 12 sub villages. In the 8 central sub villages HH live very close to each other. At the edges of the villages, houses get more scattered. In table 4 characteristic features of Ilolo are listed. In Ilolo, several NGO projects have already taken place, e.g. a village office was donated by Oxfam, different farmer groups were introduced by organizations or PROLINOVA organized innovation projects together with farmers.

Table 4 Ilolo: characteristic village features

Category	Features
Natural	Semi-arid climate
Natural	Wetland
Physical	15 solar panels
Physical	4 milling machines
Physical	Groundnut processing
Physical	Oxen and oxen carts for rent
Physical	High mobile phone network coverage
Physical	Proximity to Mvumi
Physical	Main road connecting Dodoma & Mvumi
Financial	Village community bank
Social	Gogo people
Social	Christians

(source: K.D. Mutabazi, 2013; own observation, Feedback seminar, Ilolo, 19.04.2014)

3.1.3 Morogoro

Morogoro is located ca. 200km to the west of Dar es Salaam. The region is less poor than Dodoma. Literacy rate is higher with 85.1% of men and 73.3% of women being able to read and write (URT, 2012). Life expectancy at birth for men and women is the same of 52 years (Knoema, 2006).

Climate is semi-humid with short rains from October to December and long rains from February to May. 800 to 1400mm of rainfall can be expected. Vegetation includes woodlands as well as bushed shrubland and grassland. The semi humid climate in Morogoro tends to be more favorable for agricultural production than the semi-arid climate in Dodoma. Drought scenarios are rather new in the region but occurred, according to participants' information three years in a row before 2013. Especially short rains are no longer reliable.

Of the total number of 298.421 agricultural HH in Morogoro, 85% have only crop production as their major agricultural activity (URT, 2012). In both CSS in Morogoro, a former sisal estate led to internal migration from many parts of Tanzania and thus, to high ethnic diversity. Village people are almost exclusively crop farmers. On average HH cultivate on 2.2 ha (URT, 2012). Most commonly annual crops in monoculture are grown (55.7%), least common are trees (0.4%). Preferred crops are maize as food crop and simsim as cash crop.

Keeping high value livestock such as ruminants is less common in the region. Only 6% of households keep cattle and only 3% make use of animal power (URT, 2012).

3.1.3.1 Kilosa

Kilosa district is located to the west of Morogoro town in east central Tanzania.

The district covers a total area of 14.245km², of which 536.590ha are suitable for agriculture, 483.390ha are under natural pasture and 323.000ha are Mikumi National Park (F. Graef et al., 2014).

Conditions of the district allow, among others for the growing of maize, sesame, rice, sorghum, banana, cotton and vegetables. Livestock is mainly kept by the Masai and Sukuma tribes, which emigrated from other regions. The district is one of the settings of recent bloody land conflicts between pastoralists and crop farmers. The government allocated land to the pastoralists but this intervention did not help to solve the conflict because the areas did not match with stocking rates and had a lack of watering infrastructure (K. Mutabazi, 2013). So the pastoralists continued to extend grazing into cropland areas.

In a livelihood study of P. Vedeld et al. (2012) the authors are additionally pointing to another source of conflict in the region: the impact of the Mikumi National Park on local livelihoods. The authors conclude that results of attempts to reduce tensions between the park authorities and farmers are negligible and that the park can create a substantial constraint for people securing their livelihoods (P. Vedeld et al., 2012).

In Morogoro, selected CSS are Ilakala and Changarawe. The researcher spent more time in Ilakala because Ilakala is more remote, has less infrastructure (road, telecommunication, public transport) and less market access than Changarawe.

Ilakala

Ilakala is positioned between Kilosa and Mikumi in a hilly area. From both towns it takes around one hour by car to arrive in Ilakala. The next bigger village is Ulaya. Mikumi national park is close. In 2005, villagers decided to preserve the nearby forest as a village reserve. The village has 6 sub villages. Some of the arable village land is still owned by a former sisal estate. That land is mainly located in the sub village Camp. In table 5 characteristic features of Ilakala are listed. It is remarkable that 38 different tribes of different religion (Christians and Muslims) live together peacefully in the village.

Table 5 Ilakala: characteristic village features

Category	Features
Natural	Semi-humid climate
Natural	Proximity to Mikumi national park
Natural	Village forest reserve
Physical	Main road connecting Kilosa & Mikumi
Physical	7 milling machines
Physical	Partial mobile phone network
Physical	6 solar panels
Economic	Sunday market for vegetables and other products
Financial	CARE community bank
Social	38 tribes
Social	Christians and Muslims
Social	Conflict between pastoralists and crop farmers

(source: K.D. Mutabazi, 2013; own observation, Feedback seminar, Ilakala 15./16.04.2014)

Changarawe

Changarawe is located next to Kilosa town. There is regular public transport available to town. The village is stretched along the main street. In the village center, electricity is available and shall be further extended to more HH. A river, flowing all year is passing by the village. The village is surrounded by forest area that is not preserved yet. Changarawe has 5 sub villages. A big portion of land in the sub villages Estate and Madisini is still owned by a former sisal estate. Each HH of the sub villages Estate, Madisini and Lyanda received two acres of this land in 2011. Even though, land titles of these acres were not officially handed over to villagers and hence, the land can still be taken from them at any time. As in Ilakala, there is a mixture of different tribes and different religions. The exact number of tribes could not be named.

In table 6 characteristic and distinguishing features of Changarawe are listed.

Table 6 Changarawe: characteristic village features

Category	Features
Natural	Semi-humid climate
Natural	Annual river
Physical	Electricity in village center
Physical	5 milling mashines
Physical	6 mashines for processing timber
Physical	Main road to Kilosa
Physical	Proximity to Kilosa
Physical	High mobile phone network coverage
Economic	2 acres estate land/HH
Financial	Village community bank
Social	Many tribes
Social	Christians and Muslims
Social	Conflict between pastoralist and crop farmers

(source: K.D. Mutabazi, 2013; own observation, Feedback seminar, Changarawe, 17.04.2014)

3.1.4 Household wealth

Among the CSS, inhabitants of Idifu were the most poor. Changarawe is the richest of all CSS. Indicators of household wealth can be found in table 7. Numbers were obtained from the Trans Sec HH survey, 2014. Among all respondents, in terms of transportation, the highest number of bicycles can be found in Ilakala and the highest number of motorcycles in Changarawe. Most ox carts are available in Idifu, also due to the amount of oxen kept in the village. Households in Changarawe seem to be more able to afford high value assets such as TVs, Radios and mobile phones.

Table 7 High value assets of transport and households as indicators of HH wealth in CSS

	Ch	Ila	Ilo	Id
(n) HH	150	150	145	150
Transport	Freq.		Freq.	
4-wheel car/truck/pickup			1	1
Motorcycle (s)	15	11	5	1
Bicycle (s)	89	95	40	43
ox carts	7	3	6	11
Household	Freq.		Freq.	
TV (s)	8	5	3	2
Video Casette player / DVD (s)	3	3	3	
Satellit Dish(s)	3	1	3	
Radio (s) and Stereo(s)	70	65	45	38
Mobile Phone(s)	90	77	53	36

(source: Calculated based on survey data from A. Faße et al. (2014): Household survey wave 1. Trans-SEC)

3.2 Data collection

Field data collection was carried out from January until April 2014. Qualitative data was collected using a participatory rural appraisal (PRA) approach. During workdays, the researcher was staying in the villages to get a better insight into on-site life, circumstances and agricultural activities and to encourage understanding of the research process and a mutual trust with the villagers. Per region, one focus village was selected where the researcher was spending more time. In Dodoma: Idifu, and in Morogoro: Ilakala were selected as those villages, which are claimed to have less market access, which are more remote and which are potentially more in need of agricultural upgrading and innovation.

3.2.1 Methods

In order to get an insight into village people's perception, interrelations and priorities, 72 participatory group discussions with a total of 461 participants were conducted as well as 11 semi-structured interviews with key informants. Five different communication tools were used for facilitation in group discussions with different farmer types. Although focus villages were selected, all communication tools were conducted in each village at least once to support the comparability of findings. Sessions and interviews were held in English and translated into Gogo (Dodoma) and /or Suaheli in all CSS. Answers in Suaheli or Gogo were translated back into English.⁵

3.2.1.1 Participatory rural appraisal

The bottom-up idea of participatory rural appraisal emerged already in the 1980's. Methods are various and often build on peoples' creativity to engage their analytic skills (A. Cornwall, O. Pratt, 2010). Visual techniques used in group workshops allow participants to express themselves even if they only have low levels of literacy and thereby, increase inclusion of all possible stakeholders (R. Percy, 1999). PRA methods hence, focus on a shared visual representation of topics and allow for their analysis by local people themselves (R. Chambers, 1994, a). Therefore, PRA was selected as an appropriate approach to realize the aim of this research. The PRA tools allowed focusing on farmers' own needs and perspectives with external scientists being rather involved as facilitators of the joint learning process (B. Kaufmann et al., 2013). Farmers should be included as main actors of the farming system to not only include knowledge of practice into the research process but also to give them a voice and choice as they are the ones that shall use and benefit from possible solutions. For further information on participatory rural appraisal including its idea, principles, methods, advantages and disadvantages please see chapter 2.3. Involvement of farmers into the ex-ante situation analysis, as undertaken in this study, is only the first step of farmers' participation and collaboration within the whole Trans-SEC project.

⁵ Work in the two regions was supported by different translators: Dodoma: Shani Saidi Hamisi, Morogoro: Nengilang'et Kivuyo

3.2.1.2 Group workshops and communication tools

Selection of participants

For participatory group discussions, participants were selected by a local contact person. Except for Iloilo, this person was always the extension officer. People were selected according to the following features: Coverage of all sub villages, difference in age, gender, and socio-economic status. Each participant could only participate once in a group discussion. Participants of the group discussions did not participate in the household survey. This had the reason that the household survey had a very different and non-participative approach. For this study, researchers were aiming at finding 'unbiased' participants who were not used to structured question-answer situations but rather felt naturally free and comfortable to get themselves involved into the discussion. Although a planned number of participants were defined beforehand, often more people than expected joined the discussion. Everyone was free to attend and get involved into the discussion (L.M. Webber, R.L. Ison, 1994).

Selection of communication tools⁶

In general classical RRA and PRA methods include, according to Cornwall, Guijt and Welbourn (1993), interview and sampling methods and group and team dynamic methods. This study was setting a strong focus on the latter. Here, Conroy (2001) is again subdividing possible tools into timelines and historical profiles, mapping and modeling, ranking and scoring, and matrices and diagrams. To select appropriate tools out of this wide range of options insights were given by various manuals, which will be reviewed in the following in reference to the single tools, and by a one week seminar on 'Local knowledge' in December, 2013 at University of Kassel. Selected tools were adapted to the situation, because as Chambers (1994, a) points out, PRA shall be a flexible process rather than relying strictly on instructions by manuals and shall follow the researchers '*own best judgment at any time*' in order to suite site-specific circumstances.

Conroy (2001) introduced in his guide to participatory situation analysis three steps for undertaking a situation analysis. He recommends starting with general information on the livelihood system and after, to move on to a description of the production system and then gradually focus on important issues and constrains (C. Conroy, 2001). Furthermore, he recommends to identify different sub groups of farmers in the beginning because different production systems may also face different constrains that require different interventions (C. Conroy, 2001). Those recommendations were followed in this study. Single tools were building on each other. Livelihood mapping and profiling as well as resource maps were focusing on the general situation, net maps and livelihood tools were important to identify subgroups among farmers, seasonal calendars helped to describe production systems and problem trees were aiming at an in-depth analysis of causes and effects of problems in agriculture.

⁶ Appropriate PRA tools were discussed and selected beforehand and tried at least once with Prof. B. Kaufmann and Dr. M. Lelea in the villages Iloilo and Idifu.

An overview of selected communication tools (including the number of sessions and participants for each village) and the information obtained is given in table 8.

Table 8 Overview of communication tools*

Tool		No. of sessions				No. of participants				Information obtained	
		Id	Ilo	Ila	Ch	Id	Ilo	Ila	Ch		
Resource map	male		1	1		2	4	4	2	structure of the village availability and accesability of resources	
	female	mg	1	0	mg	2	4	0	2		
	<i>total</i>		1	2	1	1	4	8	4		4
Livelihood analysis	male		2	mg	2	2	12	8	12	12	Livelihood activities and strategies segregated by gender assets, time constraints
	female		2		2	2	12	8	12	14	
	<i>total</i>		4	2	4	4	24	16	24	26	
Seasonal calender crop	male	mixed groups				5	10	12	6	Structure and timing of farming activities gendered activities Constraints	
	female	mixed groups				9	4	12	7		
	<i>total</i>	2	2	4	2	11	14	24	13		
Seasonal calender livestock	male	mixed groups				5	10	7	0	Structure and timing of livestock activities gendered activities Constraints	
	female	mixed groups				10	7	5	0		
	<i>total</i>	2	2	2	0	15	17	12	0		
Net map	male	1	1	1	1	6	6	6	6	Social relations and networks Family structure gendered activities	
	female	1	1	1	1	6	6	5	6		
	<i>total</i>	2	2	2	2	12	12	11	12		
Problem tree crop	male	1	1	1	1	7	6	6	6	Constraints in crop farming diferentiated by gender cause - effect relations coping strategies	
	female	1	1	1	1	6	5	6	6		
	<i>total</i>	2	2	2	2	13	11	12	12		
Problem tree livestock	male	1	1	1	mg	10	6	6	4	Constraints in Livestock keeping diferentiated by gender cause - effect relations coping strategies	
	female	1	1	1		8	7	5	3		
	<i>total</i>	2	2	2	1	18	13	11	7		
TOTAL		16	13	17	12	97	91	98	74		

* Id: Idifu, Ilo: Ilolo, Ila: Ilakala, Ch: Changarawe, mg: mixed groups

Addressing gender

Women and men are both important actors of farming systems in Tanzania. R. Chambers (1994, a) was reporting about a bias in former studies towards working together rather with men than women and rather with rich than poor people. To look instead for men's and women's' different kinds of truth and to thereby, get a more complete picture of the situation, one needs to look more closely into the gender and equity dimensions within the system (J.H. Momsen et al., 2013). This will set a baseline to which innovation design should be geared to but also to which program impacts can be measured. The approach chosen here was aiming at creating spaces for women and men to contribute their perspective, needs and constraints. Gendered roles in agriculture, livelihood tasks and activities, strategies and access to resources should be revealed as well as aspirations and ideas of men and women to improve their livelihoods and the constraints they are facing when trying to do so. Therefore, livelihood analysis, net map and problem trees were discussed in groups segregated by gender. During the trial of the tools in the first week, it became obvious that gender differences are strongest related to those topics. This point is supported by Oberhauser et al. (2013), who recommend a gendered livelihood approach as this helps to disaggregate households and household members according to the different goals they pursue and constraints they face. To create a comfortable atmosphere, especially for women when debating sensitive topics, sessions were held in separated areas where

no man was listening or interrupting (A. Cornwall, 2003). The discussion was always supported by a female translator. Specific topics discussed were aligned during discussion to the position men and women took in their society. Since neither men nor women are a homogenous group as such, when selecting participants attention was also paid to age, socio-economic background and family situation (A. Cornwell, 2003).

Resource maps and seasonal calendars were developed in mixed groups. Women as well as men expressed that most agricultural activities are conducted together; differences only exist in the details. Hence, as those tools- resource map and seasonal calendar- were rather meant to give an overview of the situation and production system it was convenient to do them in mixed groups. Furthermore, some mixed groups also offered the opportunity to get an idea about group dynamics when men and women have to work together, as is the case for real-life situations.

Implementation

Together with the local contact person, morning and afternoon workshops were organized in agreement with the participants. Each session took around 1.5 to 2 hours. In all sub villages, discussions were conducted in separated rooms or areas.

Material (pens, paper) was provided by the researcher. With the agreement of participants, group discussions were recorded with an audio recorder; notes were also taken. Posters with tables or graphs and calendars were developed together with participants during the sessions. Photographs were taken of all the posters.

Participants were remunerated for their time and effort at the end of the workshop.

Resource map

Participatory mapping was described by Chambers (1994, a), in a summary of PRA methods, as a tool in which local people create for example a map of their natural resources or of their farms. The researcher learned more specifically about this tool and how to make use of it during a seminar on 'Local knowledge' (B. Kaufmann et al., 2013, University of Kassel).

Resource maps were developed in each village in mixed groups. One session was held as a starting activity in the beginning of the researcher's stay in each village. The tool was aiming at identifying and locating the important, physical and natural assets of the village and neighborhood for the farmers, and to get a first insight into the structure and setting of the village.

Participants were asked to draw a map of their village and to indicate, for them, most important spots. The researcher was not interrupting the development procedure of the map. After finishing the map, the participants explained and presented the map to the researcher. Only in Ilakala, participants preferred to give explanations already during the development of the map.

Despite originally planning for groups separated by gender, in three of four cases this could not be realized. The activity took place at the day of arrival so information was already given before arrival to the responsible person. Therefore, participants were selected by the village head and did in most cases not fit with the researcher's criteria. In Morogoro in both villages, the village head participated in the session. Nevertheless, in all cases it was an interesting introduction into the village and revealed information

on village and sub village boundaries, the village development and on some natural and physical assets.

Livelihood analysis

Livelihood frameworks are various but, according to Oberhauser et al. (2013), all refer to the basic elements of peoples' livelihood resources, livelihood strategies and livelihood outcomes. Ellis (2000) defines livelihoods as "*the assets (natural, physical, human, financial and social capital), the activities (strategies of use), and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household*" (p. 10). Oberhauser et al. (2013) point out that thereby a livelihood approach allows for a people centered perspective.

Livelihood was discussed in each village in four workshops, two for men and two for women, to identify gendered activities and livelihood strategies. Livelihood is a highly gender specific topic, as often access to and use of resources, strategies chosen and thus, outcomes differ for men and women (A. Oberhauser et al., 2013). The tool tested if this assumption also holds true for the CSS.

The first session, a livelihood mapping, and second session, the development of livelihood profiles, built on each other. In the first session, male or female participants were asked to identify all productive livelihood activities that they undertake and to develop respective common symbols on a map. For all productive livelihood activities it was briefly discussed: what is done, by whom it is done and when it is done. Furthermore, not only single livelihood activities but rather the strategic situation in which to decide for one or another activity was discussed.

In the second part, a table was developed for the identified most important livelihood activities based on the first discussion. New participants were asked if they are conducting the same activities. In the positive case and due to time constraints participants selected the, for them, two or three most important activities for which each column was debated and filled with information. Columns contained information on the timing, resources used, outcomes, constraints and stakeholders of each activity. Those topics were geared to the Harvard tool to determine activity profiles and to gender disaggregate activities. March et al. (1999) elaborate that the Harvard activity profiles are an easy tool to start discussions and offer a clear picture of the gender division of labor. Nevertheless, March et al. (1999) were also pointing out, that the tool is revealing facts rather than relationships. However, the profiles were just offering a base for discussion and relationships were discussed verbally.

Because livelihood was discussed in detail in several groups a lot of information could be obtained about gendered livelihood activities and strategies as well as the circumstances under which they are taking place.

In figure 5 an example of the table of the second session can be seen.

Shughuli	Muda	Matokeo	Rasilimali	Changamoto	Washirika/wadai
	10-03 MWERI	PESANA CHAKULA	- JEMBE - PANGA - SHOKA - NYENIGO	- KUCHELEWESHE WA MALIPO - KUALIBIKA KUWA VITENDE A KAZI - KIBALUWA HAKIPO	
	KUKU NA BATA	- KITOWEO - KUZA - MAYAI	- CHUMBA CHA KUKU - KIBANDA - CHAKULA - MASI	- MAGONJWA - WADUU - KUIBIWA	Interchidi
	KILIMO			- MBEGU ZA KIENYESI - INAZAO YOTE - MBEA - MAGONJWA - MAJANI KWA MWERI	

Figure 5 Livelihood analysis part 2: Ilakala, men, 17.03.2014 (photo: M. Höhne)

Net map

Originally it was planned to develop, in a moderated discussion a net map following the idea of E. Schiffer (2008): A network map of all actors should be drawn including links, flows of resources and information; relations should be discussed as well as the distribution of activities. In the last step, actors should be put on influence towers to indicate power relations (ibid.). Net maps are a rather innovative empirical research tool that combines social network analysis and power mapping tools (ibid.). Its advantages are that implicit relational concepts can be visualized and thus made explicit; also actors' characteristics and how they are linked to one another can be made obvious. Thereby, workshop participants can learn about their own position in the community and get a tool to discuss their views with others (ibid.).

The tool turned out to be too complex and a lot of time was needed to explain all parts. Therefore, the tool was simplified and adapted for women and men groups separately. In each village, one discussion was held with six women and one discussion was held with six men. In the female groups, the tool was introduced by asking for differences among farming families in the village. To approach this question, differences were made obvious by looking closer at individual household members. Because women are the ones especially concerned with family relations, topics like relations among family members, tasks and activities on the household and extended family level and differences among families were dominant. In male groups, it became more convenient to talk especially about differences between single farmers than about differences on the family level. Hence, information on differences among farming families and some second order stakeholders could be revealed. Results were visualized and structured on a paper. The topic of power relations could often only be covered very narrow or in

a non-direct way. It was more convenient to include this question verbally into the discussion than to ask participants to indicate relations on the paper because it felt as if the paper connection would not do justice to the complexity of relations.

Although the structure of the tool was not kept as planned, information obtained was very interesting and complementing or triangulating information of the livelihood analysis.

Seasonal calendar

Seasonal calendars are a classical PRA tool, belonging to Conroy's (2001) subgroup of diagrams for visualization in PRA. The researcher was introduced to the idea and procedure of this tool during the seminar on 'Local knowledge' (B. Kaufman et al., 2013, University of Kassel). According to Conroy (2001) and Chambers (1994), this tool can acquire information on the seasonal dimensions of activities, the distribution of rain, routines etc.

The seasonal calendars were developed during two workshops in Idifu, one workshop in Iloilo, four workshops in Ilakala and two workshops in Changarawe. For the seasonal calendar, preferably mixed groups of three women and three men were brought together. As farmers pointed out constantly, most farming and livestock activities are conducted together by men and women, so mixed groups seemed to be appropriate. An empty calendar on monthly basis was prepared on a poster beforehand, referring to 2012/2013 in order to cover a full farming cycle inclusive of rainy and dry seasons.

In the beginning, participants were asked to remember the general weather conditions during the previous season and to visualize them in the calendar. The information given on rainfall and weather events differed a lot between each session. However, this does not necessarily mean that the information is inaccurate, as it was reported that rainfall differs a lot between sub villages.

The next step was to list all crops grown or livestock kept by participants. Due to time constraints, the participants had to select the most important ones, which were discussed in more detail. Originally, it was planned to discuss plant groups such as "vegetables" or "root crops", but this was found to be ineffective. Instead, participants preferred to speak about specific crops, since all crops have distinct features and demand for different farming activities.

During the livestock sessions, it turned out that in most cases the development of a calendar for livestock activities was not very convenient for participants. Instead, participants rather preferred to talk about different aspects of livestock keeping independent of their timing. Thus, the sessions often rather turned into open interviews.

The tool provided information about activities and how things are managed for specific crops and livestock. It looked at divisions of labor and the differences in farming between the different crops discussed and specialties in keeping certain livestock in different areas were pointed out. The tool also worked to identify problems at different stages of production.

In figure 6 an example of a seasonal calendar in Idifu can be seen.

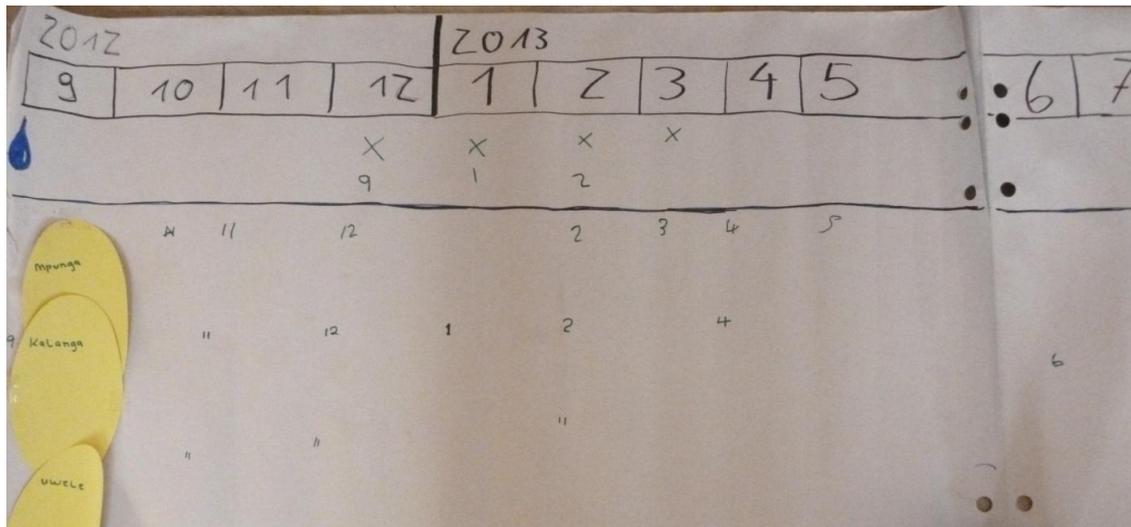


Figure 6 Crop calendar: Idifu, 11.02.2014 (photo: M. Höhne)

Problem tree

An in-depth problem analysis is a central part of this study and is most useful at the stage of situation identification (DFID, 2003). During the development of problem trees, causes and effects of problems are revealed and relations are discussed (DFID, 2003). Conroy (2001) is identifying the development of problem trees as a useful tool to analyze problems, to reveal the perception of the farmer on problems and to get a more in depth understanding of problems. DFID (2003) is pointing out the advantage of problem trees to identify underlying issues that may affect the sustainability of development benefits.

Problem trees were conducted for livestock and crop farming. Groups were differentiated by gender to see if men and women report a different perception and priority of problems. In the beginning, each participant was asked to individually write or draw own problems on a piece of paper. Problems were often mentioned several times by different participants, thereby indicating the relevance of the particular problem. When all problems were collected, they were sorted by topic by the moderator and then discussed in detail. The discussion included a detailed explanation of the problem and attempted to identify possible connections with other problems, highlighting various cause-effect relations. Ideas of possible solutions were always encouraged. In the end, the tool resulted in a structured picture of problems, constraints and their inter-linkages on a poster. In Figure 7 an example of a problem tree developed by men in Ilakala can be seen.

Table 9 Overview of key informant interviews

Interview	No. of participants				Information obtained
	Id	Ilo	Ila	Ch	
Farmer group	5	9	2	4	Type, reasons, benefits and constraints of farming groups
People > 65 years	4	-	4	-	Village history, farming history, situation of elderly people in the village
Extension officer/contact	1	1	1	-	Background information
Village head	1	-	-	-	Structure and development of the village
Local trader	1	-	-	-	Personal experience

3.2.1.4 Feedback seminars

After the initial group sessions, feedback seminars lasting around 2.5 hours were organized in all CSS. They were essential to report back to participants, to clarify open questions and to check the reliability of findings together with the informants in order to reduce bias. Feedback seminars started by recalling information about why the research was conducted, for whom and for what purpose this information has been collected. The seminar continued with presenting posters, prepared by the researcher that summarized village specific information on different topics. Topics discussed included resources and assets, livelihood, and a discussion about the strengths, weaknesses, opportunities and threats for agriculture in each village. After every introduction to a topic, a critical discussion with the participants took place. Participants were encouraged to contribute to the posters. All sessions were recorded and partly transcribed.

Table 10 Overview of feedback seminars

	No. of sessions	No. of participants		
		m	w	total
Idifu	2	11	10	21
Ilo	1	10	4	14
Ilakala	3	12	10	22
Changarawe	1	5	5	10

3.3 Data handling and analysis

3.3.1 PRA tools and feedback seminars

Audio data and visual data was summarized and transferred into documents in form of field notes, audio protocols and tables. Complete translations and transcriptions of audio data were only done for single sessions, which contained a lot of information. Here, transcription and translation was done by Tanzanian translators. For all other sessions, the part of the English sections of the audio record was transcribed or paraphrased by the researcher. In table 11 the completely transcribed and translated sessions are listed.

Table 11 Complete translated and transcribed sessions

Village	Tool/Interview	Gender
Idifu	Net map	Women
	Livelihood analysis	Men
	Seasonal calender: rice, groundnut, millet	Both
	Seasonal calender: cow, goat	Both
	Problem tree: livestock	Women
	Interview: people > 65 years	Both
Ilolo	Livelihood analysis	Both
	Problem tree: crops	Men
	Seasonal calender: cow, goat	Both
	Seasonal calender: pigs	Both
	Interview: farmer groups	Both
Ilakala	Livelihood analysis	Women
	Livelihood analysis	Men
	Net map	Women
	Net map	Men
	Problem tree: crops	Men
	Seasonal calender: simsim	Both
	Seasonal calender: cattle	Both
	Problem tree: livestock	Women
Interview: people > 65 years	Both	
Changarawe	Net map	Women
	Net map	Men
	Livelihood analysis	Women
	Livelihood analysis	Men
	Problem tree: livestock	Both

3.3.1 Qualitative content analysis

Information from the following tools was used for deeper content analysis: Livelihood analysis, net map, seasonal calendars and problem trees. Those tools were selected because of the high quantity of information obtained. However, in Ilolo the seasonal calendar for vegetable production was not successfully conducted and, hence, is not used for further analysis. Resource map sessions were excluded because participants did not fit with the researcher's criteria and did not represent the farmer's perspective as such. Basic information from the field notes of the resource maps, the key informant interviews as well as the feedback seminars was used to complete findings.

Table 12 Data handling

Handling	Number
Conducted group sessions and interviews	83
Translated and transcribed	25
Paraphrased	29
Field notes	18
Left out	1
Missing audio records	2
Used for content analysis	54

In the following step the paraphrased or translated information of the 54 documents (compare table 12) was categorized and coded using the software R (RQDA). Codes were specifically applied for more precise but repeated topics within text segments and were summarized in several code categories. The code categories build the structure of further analysis and sorting of results that can be retraced in the following chapter. Using the software simplified the work of sorting, restructuring, extracting, generalizing and summarizing the information for each category. The so obtained condensed results are summarized in tables and descriptive text for better comprehension. A multi-vocal technique was used to optimally present the farmers point of view. Therefore, full participants' quotes were selected out of the coded text material to underline findings.

4 Results

Results are presented in three main parts. The first part identifies the importance of farming and livestock activities within the CSS and highlights livelihood dynamics for different sub groups of farmers. In the following, dynamics of the farming systems are explained in depth considering the farming context, resources and underlying relations for different CSS and different farmers. Both, the first and the second part, set the frame of the farming system and highlight differences for different types of farmers. In the third part we will look more closely into what is actually happening within this frame and will identify specific problems for crop and livestock production along the chain of production and as discussed with participants. Those point to the major issues that should be tackled with innovation design.

4.1 Livelihood activities

The following section identifies the major livelihood activities in all CSS and reveals the importance of agriculture for people from all villages. Based on the different livelihood activities, different livelihood strategies shall be revealed. Differences in livelihood strategies illustrate differences among farmers. This will allow for a first basic stakeholder identification based on livelihood activities. The identified stakeholder groups form the basis for further differentiated analysis in the following chapters.

In table 13, all activities that were mentioned in the tools focusing on livelihood activities as well as net map are listed. Activities are sorted by categories. In the following section, the major activities related to agriculture will be explained concerning

4.1 Livelihood activities

their importance for peoples' livelihood. Furthermore, off-farm activities will be grouped and related to agriculture, which will help to identify different types of farmers.

Table 13 Livelihood activities

	Activity	Outcome	Place	Time	Resources	Involved persons		Village	
						Gender	Others		
Farming and Livestock	Crop production	Nutrition, seeds, income, barter	Field	Rainy season	Seeds, hand hoe, ax, bush knives, dagger, scalpel, sack, bags, sheets, inputs, transport (ox hoe, tractor)	Both		All four	
	Vegetable farming	Nutrition, seeds, income, barter	Wetland (D), near river (M)	Specifically starting from June onwards, after rainfall (llakala), 2	Hand hoe, bucket or pump for irrigation	Both		All four	
	<i>High value livestock:</i>								
	Cattle	Income, offspring, animal power, milk	Pasture area: private or common land	All year	Stick, special shoes, sometimes arrow, bush knife, medicine	Both, pasture:men, milking: women			All four
	Small ruminants	Income, offspring, (Goat:milk)	Pasture area: private or common land	All year	Stick, special shoes, sometimes arrow, bush knife, medicine	Both, pasture: men			All four
	Pigs	Income, offspring	Home	All year	Fodder, water, stable, medicine	Both			All four
	<i>Low value livestock:</i> Poultry	Income, nutrition	Home	All year	Water, medicine, (fodder, stable)	Both			All four
Bee keeping	Income, honey	Forest	<i>Not specified</i>	Bee hives	Both			llolo, Idifu, llakala, Ch?	
High income activities	Shop	Income	Shop	Full employment	Capital, building	Men		All four	
	Milling machine	Income	Milling machine	<i>Not specified</i>	Capital, milling machine	Men		All four	
	Local trader	Income	Village	Harvesting time	Capital	Men		All four	
	Local seed supplier	Income	Village	<i>Not specified</i>	Capital, storage facilities	Men		llolo	
Skilled labor and/or capital demanding activities	Hair saloon	Income	Saloon	Full employment	Solar panel, building, machine	Young men		llolo	
	Tailor	Income	Home	<i>Not specified</i>	Sewing machine	Both		All four	
	Butcher	Income	Butchery	In rotation once a week	Tool kit	Men		(All four)	
	Carpenter	Income	Home	On demand	Tool kit	Men		All four	
	Motorcycle driver, transport	Income	Village	On demand	Motorcycle	Men		All four	
	Repairing motorcycles	Income	Home	On demand	Tool kit	Men		llakala, Changarawe	
	Renting bicycles	Income	Village	On demand, best time during harvest, weather dependent	Bicycles	Men		All four	
	Repairing bicycles	Income	Home	On demand	Tool kit	Men		llakala, Idifu, Changarawe	
	Repairing radios	Income	Home	On demand	Tool kit	Men		Changarawe	
	Repairing sewing machines	Income	Home	On demand	Tool kit	Men		llakala	
	Repairing shoes	Income	Home	On demand	Tool kit	Men		All four	
	Selling fuel for motorcycles	Income	Village	Every week	Capital, bicycle, tank, 1 l bottle	Men		Changarawe	
	Small shop "Genge"	Income	Home, next to the street	Seasonal, during farming activities afternoons	Capital, some stand construction	Both		All four	
Home construction	Construction of houses	Income, accomodation	Village	On demand	Labor	Men		All four	
	Making bricks	Bricks	<i>Not specified</i>	On demand	Material	Men		llakala, others not specified	

4.1 Livelihood activities

Preparation of food	Making and selling of local alcohol	Income	Brewing at home and selling at community place or bar	Preparing once a week, evening activity, selling every day	Banana or millet, sugar, pipa (like a tank), water (from the well for free, nearby)	Women		All four
	Cafeteria	Income	Small buildings (for rent)	Full daily job	Small building/hut; cooking utensils, food, capital	Both		All four
	Selling pastries (Mandazi, Chapati, Donuts)	Income	Home, Village	All year	Flour, yeast, sugar, oil, cooking utensils	Women		All four
	Roasting and selling Cassava	Income	Nearby the road (CH), school (Ilak)	During cassava availability	Cassava, cooking utensils	Women	Children	Ilakala, Changarawe
	Cooking and selling banana	Income	School	During Banana availability	Banana, cooking utensils	Women		Ilakala
"Women for women" activities	Selling underwear or other clothes	Income	Village	<i>Not specified</i>	Capital	Women		Ilakala, Idifu
	Plaiting hair	Income	Home	June/July to October/November	None	Women		All four
Handcraft	Pottery	Income	Home	<i>Not specified</i>	Clay soil from the mountain	Women		Idifu, Ilolo
	Making brooms	Income	Home	<i>Not specified</i>	Baobab	Women		Ilolo
	Making baskets	Income	Village	<i>Not specified</i>	Material to buy or from the forest	Women: plitting, men: preparing the basket	Clan	Ilakala
	Making ropes	Income, Ropes	Home	<i>Not specified</i>	Baobab tree, leather	Men		Ilolo
Wage labor	Making mats	Income	Home	<i>Not specified</i>	Material	Both		Ilolo
	Wage labor	Income	Farm of others inside (and outside: Idifu, Ilolo) the Pasture site	In times of need, especially shortage of food	Farming equipment	Both but majority men		All four
	Herding: wage labor	Income, milk, meat	Pasture site	In times of need	Stick, special shoes, sometimes arrow, bush knife	Men		Idifu, Ilolo
Other low capital demanding and generating activities	Collecting firewood	Income, firewood	Village	Moments of need	Bush knife, means of transport	Women	Elderly people	Idifu, Ilolo
	Collecting and selling fruits	Income, nutrition, wood	Village	Fruit season	Fruit tree	Both		All four
	Selling vegetables	Income	Community place	After vegetable harvest	None	Both		All four
	Charcoal making	Income	Village	Dry season	Ax, saw, bush knife	Both		All four
	Fishing	Income, nutrition	Village	Mai to November, 2-3h	Fishing rod	Men, selling: women	Children	Changarawe
	Selling coffee	Income	Village	After harvest	Coffee, low capital demand	Men	Men	Idifu
Others	Governmental employees: e.g. teacher, extension officer	Income	Office	Full employment	<i>Not specified</i>	Both	Immigrants, higher education	All four
	Pastor	Income	Church	Wednesday, Friday in the evening and Sunday	<i>Not specified</i>	Men		All four

(Source: Livelihood analysis, net map)

4.1.1 Agricultural activities

Agricultural activities in all CSS include crop, vegetable and livestock production. The three activities are of different value to the farmers. Their importance will be highlighted in the following section.

4.1.1.1 Crop production

During all sessions and in all villages, participants stated that crop farming is their major livelihood activity. The first objective of crop farming is to generate food for the family for the next year as well as seeds for the next farming season (compare table 13). Most important food crops are millet in Dodoma and maize in Morogoro. According to their capabilities, people additionally engage in cash crop farming and marketing to generate a family income. The major cash crop in Dodoma CSS is groundnut and sesame in Morogoro CSS. As participants expressed, limitations for cash crop cultivation occur due to limited space and time but also due to high external input demand and limited marketing channels:

Woman:

“You can also cultivate sesame, but not get high output because the sesame requires pesticides and you cannot afford to buy the pesticides.” (Net map, Ilakala, 18.03.2014)

Man:

“The food crop grower may also grow cash crops, but in a smaller amount because the problem is he does not know where to sell. The ones with the food crop may sell to those with a lot of cash crops but for a low price and they have a good connection to outside traders.” (Net map, Ilolo, 19.02.2014)

Even though crop farming is the major activity, it is also a seasonal activity limited to a certain time frame. Climatic conditions usually allow for farming activities from October/November up to July/August. Due to its importance for the family wellbeing also all family members are engaged in crop farming activities.

4.1.2.2 Vegetable farming

In contrast to crop farming, vegetable farming is limited to a more exclusive number of villagers; hence, has to be stated as an individual activity. It is highly dependent on the quality and type of land owned or rented by individual farmers. Demand for artificial inputs and investment is usually high. For those who are vegetable farmers income out of this activity is noteworthy. Although it appears to be a lucrative undertaking, vegetable cultivation is limited in all CSS by the availability of suitable land. In Dodoma CSS, vegetables are cultivated in wet lands, which are recharged by a high groundwater table. In Morogoro CSS, vegetables are cultivated near the river. The area in Changarawe is much more suitable for vegetable cultivation than in Ilakala. It is so attractive that even outsiders came and continue to come to purchase land near the river to start big horticulture projects. Accordingly, land prices for wetland plots as well as river side plots are much higher than for average plots. Due to its high income

generating potential, vegetable cultivation was taken up by farmer group initiatives in Ilakala and Changarawe. These initiatives were introduced by external organizations, are still rather new and are aiming at making farmers more familiar with vegetable farming practices while offering an opportunity for income diversification.

4.1.2.3 Livestock production

Apart from crop farming, a big livelihood activity is livestock keeping. If a household consists of husband and wife, the man is usually the owner of all livestock. Looking at livestock keeping in more detail, one can recognize different dynamics when differentiating between high value and low value livestock. The author of this study is defining cattle, small ruminants and pigs as high value livestock within the CSS. As the numbers in table 14 indicate, in Dodoma CSS the importance and density of high value livestock is much higher than in Morogoro, with on average half of the interviewed households keeping high value livestock. Most important are goats, pigs and oxen, followed by beef cattle. A less important role in both Dodoma CSS is played by dairy cattle.

Table 14 Livestock distribution CSS

	Changarawe	Ilakala	Iloilo	Idifu	Total
HH	150	150	145	150	595
Keeping Livestock	Number of Households				
no	52	47	50	50	199
%	34.6	31.3	34.5	33.3	
yes	98	103	95	100	396
%	65.3	68.6	65.5	66.6	
Animal species	Frequency				
Beef Cattle	2	6	22	18	48
Chicken	90	95	57	77	319
Dairy Cattle	1	3	11	6	21
Duck	14	7	7		28
Goat	1	10	41	30	82
Oxen		1	26	17	44
Pig	7	1	33	26	67
Sheep			12	12	24
Turkey			1		1
Bees			7	4	11
others		2	2	1	5
	Number of Households				
High value livestock (ruminants & pigs)	9	16	83	74	182
%	6%	11%	57%	49%	

(Source: Calculated based on survey data from A. Faße et al. (2014): Household survey wave 1. Trans-SEC)

In Dodoma, high value livestock was always appreciated by the traditional Gogo livestock keepers. Since 1989, the stocks in the region are increasing again, which can also be verified for the Dodoma CSS. Livestock keepers in both Dodoma CSS can

especially be found at the edges of the villages, where wide unpopulated land is suitable for pasture. Activities are highly gender specific (compare table 16, section 4.2.1). For the participants, the important tasks of pasture and trade are taken over by men. Women are mainly responsible for activities that can be conducted around the homestead, such as feeding or milking. Livestock constitutes a big portion of family wealth and is interlinked with traditions of the Gogo and the local circumstances. For example in the semi-arid area of Dodoma where crop farming output is less, people find livestock as a strategy to diversify income:

Man:

“Another way to overcome the rainfall problem is livestock keeping. When we lose crops then we depend on the stocks. You sell the goats then your child gets food. Rain is out of our control.” (Problem tree crop, Ilolo, 18.02.2014)

Therefore, also more time, effort and capital are invested to keep the herds healthy and increasing. For the owner of high value livestock it is generating a remarkable and regular part of family income when either selling animals, selling milk, or renting for animal power.

Differently to ruminants, women are stronger engaged in pig keeping, because they are the ones who stay closer to the homestead; hence, also take care e.g. of the feeding of the animals in stables. Pigs are feasible livestock for single female households. Many single women in Dodoma keep pigs.

“Feeding the pigs is done by women; buying food is done by men. Many women are pig owners.” (Referring to single women, Calendar pig & chicken, Idifu, 13.02.2014)

In Morogoro CSS, high value livestock is less important for the family livelihood. However, it remained an open question how to rank pastoralist in the two Morogoro CSS. Crop farmers do not consider them as village members; hence, they should from their point of view, also not be relevant for project consideration. Nevertheless, some of the pastoralists stay for a long time at the edges of the villages. They follow a very different lifestyle and are considering livestock keeping as their main source of income. Those, who settled in the villages, engage as well in crop farming since they recognized the benefits of crop farming for their own livelihood (Calendar cattle, Ilakala, 24.03.2014). Although not negligible, those who are permanent village residents still form a minority within the two CSS and since their status is not clear, for the sake of simplicity their livelihood strategy will not further be discussed in this study because livelihoods of pastoralist could constitute an own study in itself. Nevertheless, for further studies their status should not be neglected.

In comparison to high value livestock poultry, especially local chicken can be found almost in every household in all CSS. In Morogoro CSS, the frequency of poultry is slightly higher than in Dodoma. Poultry is cheap, easy to access and has a low input demand. As such, they are a fall back resource in terms of food and family nutrition but especially to ensure economic liquidity. In times of need, poultry can be easily sold within the village to generate instant money.

Man:

“Also when you want to do a business, or your child is sick and in need of medicine. Then you sell a chicken, you get some money and then you buy medicine.” (Livelihood 1, Ilakala, 15.03.2014)

Woman:

“Some chicken we eat and some we sell when we have a problem.” (Livelihood 1, Changarawe, 01.04.2014)

Other poultry apart from chicken are ducks, pigeons as well as guinea fowls that are only domesticated in Dodoma CSS. Within the households, usually women are the ones who are responsible for taking care of the poultry.

“The woman is the one who takes care of food in the family so chicken also helps them to have food in the house. The woman is the one who is also cleaning the house of the chicken, for a man it is difficult to stand up and start swiping. When he buys a chicken he gives it to the women.” (Calendar pig & chicken, Idifu, 13.02.2014)

Due to their low price and shorter development and trade cycles than for high-value livestock, usually the effort in terms of time and investments into poultry is smaller. Losses of single animals are easier to cover than losses of big animals that demand more time and effort to grow into a tradable size.

For further explanation on livestock keeping please compare chapter 4.4.

4.1.3 Off-farm activities

Being the main activity, crop farming is shaping peoples livelihood strategies tremendously. The next level of results reveals that basically almost any other off-farm activity is to certain extent interlinked in a positive or negative way with agriculture, either in terms of time, labor demand and/or capital. The combination of agricultural activities and agricultural activities' output with off-farm activities and off-farm activity's output is in the end underpinning the economic status of farming households and leads to a typology of farmers that will be revealed in part 4.1.4.

In all CSS, lacking infrastructure and market access limit the options for high income generating off-farm activities, although there is a variation among villages and sub villages. However, according to their capacities people engage in all-year or seasonal off-farm activities.

Different off-farm activities generate different proportions of family income and are undertaken for different reasons sorted to different types of farmers. This sentence might seem very trivial in the first run but is quite complex to unfold. At this point it makes sense to structure activities again considering two aspects in the face of this study: priority in relation to agriculture and dependency on agriculture. It is suitable to categorize activities also in terms of opportunity costs and HH income proportion

generated. According to these parameters, three major “activity groups” can be identified:

4.1.3.1 Off-farm “activity group 1”: High capital contribution to agricultural activities

All those activities that contribute a regular high proportion to the family income and thereby, generate a HH capital stock that is allowing for further investments are part of the first group of activities. In table 13 those activities include shop keepers, processing entity holders, local traders and owners of a cafeteria. Interestingly, all of them create part of the upstream (input supply) or downstream sector (processing, marketing, retail) for agriculture.

Although the activities demand a lot of time, during the workshops the holders of these activities were claiming that still, being a farmer is their major profession. Hence, capital obtained through other activities is often invested to improve and/or secure farming practices. This is allowing for developing farm management, increasing external inputs and is making the person less dependent on environmental factors. It is also allowing the person to purchase certain farming tools like oxen/livestock, tractors, vehicles or processing machines that can again be rented out to others and thereby, increase HH wealth. But this also means in order to keep the farmer’s farm management level he or she is highly dependent on the income of the off-farm activities. Keeping the status quo, the activities could exist on their own as main profession of the person undertaking it. One could claim that in contrast to their own perception, these farmers are rather part-time farmers. Nevertheless, according to participants, farming is still an important pillar for livelihood.

All activities demand either a certain level of education and/or a certain level of economic thinking and entrepreneurship. However, in terms of agricultural output opportunity costs of not doing this activity are quite high for the farmer because otherwise, the farm management level could not be kept. Therefore, dependency of agriculture on the first group of activities is very high.

An interesting case of a successful strategic farmer is the local main trader in Idifu, who started his growing business just with small chicken and egg trade and thereby, developed to one of the most important people in the village. He is now the main trader throughout the whole year as well as source of credit for the villagers. Thereby, he could engage e.g. in big scale pig keeping:

Extension officer, Idifu:

“Others have many more pigs, it depends on the income if you can afford the stable and food for them e.g. Ivan has a lot of pigs, like 30, if he asks you to treat his pigs it can take all day.”

4.1.3.2 Off-farm “activity group 2”: Capital contribution to satisfy household needs

The second group of activities contains seasonal, less predictable income generating activities. They create an important portion of family capital but still, the family does not

rely on them. It serves as an additional income to satisfy HH needs. For participants these HH needs included the purchase of salt, sugar, side dishes or soap and the payment of school requirements, hospital costs or *“sometimes even a shirt”* (Livelihood 1, Ilakala, 15.03.2014, men).

Women about cooking and selling local alcohol “Pombe”:

“We do it to fulfill family needs that otherwise only with farming could sometimes not be achieved.” (Livelihood 1, Idifu, 04.02.2014)

The money obtained is spent rather independent from agriculture, although this is of course not the ultimate truth. In the end it certainly depends from time to time how much money can be generated and in how far this can be saved and used to support agriculture as well. But this already points out that by not being a safe fixed capital return, it does also not underlie high risk capital demanding management decisions. In this sense, opportunity costs are quite small in terms of agricultural output; and farming activities always come first.

In table 13 these activities include those of the categories “Skilled labor and/or capital demanding activities”, activities for the preparation and selling of food, “women for women activities” and handcraft.

A first example is to run a small street shop called “Genge”. The owner of such a shop in Changarawe expressed concerning time management:

“Sometimes if there are no people, I have to close the shop because everyone is busy going to farm, then I close too and go to the farm.” (Livelihood 2, Changarawe, 02.04.2014)

For women, there are the options to prepare and sell all kind of food products or to undertake activities that are focused on their fellow women, such as selling clothes and underwear or plaiting hair. Thereby, women are the major food processors inside of the villages. Ingredients like cassava, banana or millet for local brew are often traded among each other. As well the big group of women that are brewing beer to add on family income belong to the group. Brewing is popular in all CSS, although in Morogoro alcohol is only permitted for the Christians. It is often taking place in the afternoon or evening.

Woman:

“For instance I sell local alcohol. After I came from farming, I peel bananas and I boil them, I do that at night around 8pm. At that time everyone has already eaten and they just rest. In the morning, then I find bananas ready.” (Livelihood 1, Ilakala, 15.03.2014)

Differently to the before mentioned examples, skilled manual jobs such as carpentry, tailor or repairing all kind of tools have a higher demand on inputs and education. Although being able to generate a remarkable income, they nevertheless fall under this second category. It was reported that they are only done seasonally if the farming schedule permits some free time or whenever demand is there.

Man:

“This carpentry I do when someone comes to ask for the service, but if there is no one then I just continue with my farm activities.” (Livelihood 1, Ilakala, 15.03.2014)

They are only undertaken by a small group of people, among them exclusively men.

All activities of the second group depend a lot on the inside village capital flow after harvest. As reported, the best time for business is after harvest when people have money and purchasing power. During this time, all kinds of small activities pop up to generate a bit of cash. But whenever capital is spent, times of hardship start again and people are neither willing to spend money on handcraft or other pleasures if there is no food in the house:

Women about the business of plaiting hair:

“Would you take 7000Tsh, to take care of your hair while you have nothing to eat in the house? You would be insane.” (Livelihood 1, Changarawe, 01.04.2014)

It is to be presumed that an intermediate group of farmers between “rich” and “poor” is most likely undertaking activities of this second category that may generate more or less income according to the overall situation in the village.

4.1.3.3 Off-farm “activity group 3”: Subsistence level activities

The third level of activities is clearly undertaken because agriculture is not generating enough output to achieve food security for the whole year. In times of need, people first start selling chicken, selling household items or selling from the food stock to get money. If these sources are exhausted there are only few options, among them activities of the category “low capital demanding and generating activities” like collecting firewood, herding other peoples’ herds in the Dodoma CSS or doing wage labor on other peoples’ farms. They all have in common that these are activities that are not well appreciated by those that are forced to do them. Labor demand is high but outcome is low. The incentive to do them is in many cases pure survival.

Woman:

“It depends on the output that you are getting. Because when you get less, you cannot think about the income through business. When you get less, you just think about the food for you and your family.” (Livelihood 1, 01.04.2014 Changarawe)

The idea of opportunity costs for this last case does not work similarly as for the first and second one. Measuring opportunity costs in terms of farm output here does not work as before. Just assuming this measurement it would clearly speak against casual labor because the labor needed could be better used on the peoples’ own farms but this is not capturing the underlying problem. Opportunity costs need to be measured in food security. At this point the analysis becomes tricky because the question is popping up at which point food security is more important to focus on. Undertaking wage labor or herding for others is creating a trade-off for poor farmers between using time for farming on the own farm versus time to satisfy urgent family needs in the face of limited

labor resources. But not only that: By leaving aside own farming activities it is also creating a trade-off in terms of food security of today versus food security of tomorrow.

Wage labor

Due to its importance for the whole study, here, wage labor shall be explained in more detail.

Different reasons which will be further explained in the following chapters can lead to food scarcity in households, starting most often in December to February.

Man:

“It is from December, January, February, the time when life becomes so, so hard.”(Livelihood 1, Ilakala, 15.03.2014)

The major strategy by income limited households during these times is to do wage labor. The extent and expression of wage labor differs among all CSS.

In general, the farmers in need get employed by those people who can afford to employ others on their big farms that they would otherwise not manage alone with given labor and time. Thereby, the employers can farm on larger areas; hence, generate a higher output. The employers might as well be time restricted because they spend more time on other income generating activities than on farming. For example shop keepers, cafeteria owners, traders, butchers, owners of milling machines and governmental workers were reporting to employ laborers.

The common wage labor is related to farming: farm preparation, planting, weeding or harvest; but also other jobs that do not demand any higher skills are possible. Because in Changarawe the majority can afford a tractor for farm preparation this task is excluded for wage labor. In Changarawe people especially find employment in vegetable cultivation all year round. In both Morogoro CSS, wage labor jobs are sufficiently available inside the village. For Dodoma CSS, the situation looks different. Due to its proximity to Mvumi people from Ilolo often go there by feet to search for jobs (Problem tree crop, Ilolo, men, 18.02.2014). In Idifu, wage labor jobs are limited especially during the dry season. During that time, many men of the families travel throughout the country to regions where there is still rainfall. Usually they do not need to bring equipment but get it at the place, differently than for jobs inside the village. Women stay at home to take care of the kids.

Man:

“If you have a problem in the dry season, there are no jobs here in the dry season until the rainy season comes. And in that dry season a person may need to change and move out of the village.” (Livelihood 1, Idifu, 05.02.2014)

Elders report that this is a rather new situation. In former times it was not necessary, but also not that much possible due to restrictions in transport (Livelihood 1, men, Idifu, 05.02.2014).

Another difference for Dodoma CSS is that wage labor is also undertaken in the form of herding other people's herds. Employed herders get paid per year (Livelihood 1, men, Idifu, 05.02.2014).

In all CSS, wage labor is done by men and women. The payment was reported to be equal. Especially single female HH are often in need of doing wage labor (Feedback seminar, Ilolo, 19.04.2014). Nevertheless, because of the need for travelling in Dodoma CSS more men than women are engaged with wage labor. Women have to stay at home to take care of the children. In general the payment is a question of bargaining and depends on the hardness and duration of the job.

Several problems in relation with wage labor were reported. Main causes are the informal work conditions so that the employees basically have no enforcement power. It was claimed that people often do not get paid in time or according to the agreement or that the employer is cheating them (Livelihood 2, women, Changarawe, 02.04.2014; Livelihood 2, men, Idifu, 11.02.2014; Livelihood 2, men, 17.03.2014).

Man:

"Sometimes you work properly on the farm, but they tell you, you have to start again and again because you did not do it right or the land gets bigger than what you agreed on." (Livelihood, Idifu, 11.02.2014)

In Changarawe, men were complaining that sometimes the employer just disappears (Livelihood 2, men, Changarawe, 02.04.2014). People also complained that they have to bring their own hand hoe and if it is breaking there is no refund for it (Problem tree crop, men, Idifu, 31.01.2014; Livelihood 2, men, Ilakala, 17.03.2014). Another problem is that people are doing the jobs out of hunger so it is especially hard because they work on the farm without eating (Problem tree crop women, Ilakala, 21.03.2014). Last but not least, it is absorbing the farmer's time and labor and as a result, they start late working on their own farms (Problem tree crop, men, Ilolo, 18.02.2014). But in times of need, low income farmers do not have alternatives:

Man:

"It is because when God has created human beings he also gives each one of us a destiny/fate, and ability, for instance I don't have a bicycle to rent, I don't have a grinding machine, I don't have a shop, so to get some money to cover for immediate costs and needs that happen in my daily life I have to go to people who can employ others like those who own a shop." (Livelihood 2, Ilakala, 17.03.2014)

4.1.3.4 Special cases and trends

In general, opportunities to engage more in one or the other activities category differ among different farmer types and among villages, in some cases even sub villages.

Gender

Important to notice is that opportunities for women are very limited and related to traditional 'female' activities, e.g. food preparation (compare table 13). Nevertheless,

participants pointed out that in all CSS the number of single female households is remarkable. Those women have few opportunities to gain a notable extra income by off-farm activities, meaning their dependency on agricultural output is even higher. However, it could be observed that also many women just accept their fate and lack personal ideas and initiatives to at least start something. On the one hand, during many sessions women were demanding female empowerment, on the other hand, they are at least as much shaped by traditional gender roles as men are and sometimes lack the belief in their own capabilities. In Ilakala women were for example expressing:

Woman:

“Can we really construct toilets?, no we can’t, we can’t even cut trees, we can’t do this because unlike us men can just take an axe and know exactly that they can bring down this tree in not more than half an hour, but a woman might even take three days to cut the same tree, so they may waste a lot of time and delay to complete the task, also men use a lot of sense and strength, so this make their work easier but we women we tend to use a lot of strength and no sense so in that case you might be cutting a tree, thinking that it will fall on the other side but may in the end fall on you.” (Net map, Ilakala, 18.03.2014)

Age

Another group, the old farmers, is restricted in their physical power. In places like Idifu where off-farm activities are in general limited and employment options are low, it could be observed that old men often take over rather ‘female’ activities like the collection of fire wood. In times of need, they cannot do hard work, neither are able to travel long distances as other men do to find a job. So to still gain an extra income they may sell e.g. firewood or vegetables at the side of the street.

Interesting to mention are also special cases. In Ilolo one man explained about making ropes out of Baobab fiber, an activity which is going by clan over generations. He was the only one who carried out an inherited activity. In Ilakala the local carpenter learned as well from his brother and father but he did not see this profession as clan specific because *“anyone can be a carpenter”* (Livelihood 1, Ilakala, 15.03.2014).

Villages

Comparing infrastructure and market access of the CSS, it could be realized that with higher developed infrastructure also the variety of off-farm activities in the village is increasing, especially for unskilled seasonal activities. Same holds true for differences among sub villages. In Lugunga, Changarawe, a sub village at the edge of the village far away from the main street without electricity and fertile land, women explained about the low purchasing power within the sub village which is limiting their income opportunities.

Woman:

“No, women in the sub village do not even make mandazi or chapatti, sometimes we try but it is hard because nobody will buy them, sometimes we prepare mandazi of 1kg but they remain with us for 3 days, sometimes we go with them to Masai people

because at least they might buy them.” (Problem tree crop, Changarawe, 04.04.2014)

In general in Changarawe, participants reported about a constant increase in small activities since people were given two acres of fertile land and electricity reached the village.

“Three years ago shops opened, at the same time when people were given the two acres from sisal estate.”(Feedback seminar, Changarawe, 17.04.2014)

Major increase is happening in terms of small activities that do not have a high educational, neither input demand thus, are easy to engage in but mainly rely on the capital flow within the village. It was interesting to observe that male villagers also teach each other in certain skills of which demand is increasing, e.g. repairing bicycles or motorcycles was most commonly mentioned.

4.1.4 Subgroups of farmers

The above chapters highlight the idea that there are differences among farmers that are strongly interlinked with the activities they are undertaking and that have an effect on their income situation. In fact, the first criterions of participants for farmer differentiation were wealth classes. Summarizing results from the net map sessions, they illustrate already a first more precise differentiation of farmers. This differentiation highlights the different sub-groups of potentially rich and potentially poor farmers. It reveals attributes and characteristics that people of the CSS connect with these sub-groups. Nevertheless, sub groups are not exclusive. E.g. a rich farmer may at the same time be livestock keeper and a business man. The sub groups rather demonstrate strategies or factors that allow people to accumulate a capital stock or that hinder people from doing so. The results are summarized in table 15.

Participants differentiated very strictly into poor and rich farmers during the net map sessions. Table 15 illustrates, these categories are a result of a complex net of first: endowment with farming resources and the resulting output and profit generated with farming and livestock activities (to be discussed more in detail in the following chapters 4.2 and 4.3), second: the positive or negative interlinkages with off-farm activities and third: certain socio-demographic attributes such as gender and age that may hinder some people from getting access to resources or that determine physical power. The group of the ‘rich’ is in minority in all villages. Differences in household wealth among villages were indicated in table 7. A combination of personal socio-demographic factors, good resource endowment, successful farming strategies and off-farm activities is enabling them to accumulate a high capital stock. The poor are basically limited by low resource endowment (land, labor, capital, compare section 4.2) and risk aversion. Certain socio-demographic groups, such as women and the old are especially hindered in physical and resource terms.

Table 15 Farmers' differentiation into poor and rich HH

	Attribute	Sub-group	Attribute
Rich	Able to afford big farm with fertile soil, artificial inputs, oxen or tractor, is farming more cash crops and vegetables, has good market access ▶ high agricultural output	•The well endowed successful farmer:	
		by inheritance	Inherited fertile land
		by hard work	Able to rent or buy additional fertile land
		•The livestock keeper	Owens high value livestock, animal power, additional income
		•Off farm activities:	
		The agricultural businessman	High capital contribution to agriculture
		•The immigrants searching for fertile land	Enough capital to buy or rent fertile land
Poor		searching for a better live	Migration out of misery
	Can afford farming with hand hoe on small farm, don't use additional inputs, no high value livestock, risk aversion ▶ low agricultural output	•Poor by inheritance	Inherited unfertile, small land
		•The single female HH	Gender
		•The old	Physical power
		•"The lazy" / "The alcoholics"	

(Source: Net map)

However, it is clear to the author that there must be an intermediate between the rigorous categories of 'rich' and 'poor'. This intermediate cannot be clearly defined because it is a complex scenario of different context factors that can lead a family to shift either a bit more to the 'rich' or to the 'poor' side. It is mainly based on families' capacities and strategies and hence, vulnerability to sudden changes in the farming context they are facing. Therefore, it seemed to the author that the intersecting economic status between 'poor' and 'rich' is in many cases not stable and is critically dependent on resource endowment and agricultural output, every farming season again! Furthermore, it could be observed that the term 'rich' is stressed from those who are purely able to satisfy all basic family needs over the year and to maintain own farming activities in a sufficient way up to those that generate a very big surplus partly also due to other high income generating off-farm activities.

A group, not yet discussed, is the group of immigrants in all CSS. The perception on immigrants is very different in the villages. In Iloilo, immigrants were rather seen as negative, as rich people occupying the already scarce fertile land and thereby increasing land prices:

Man:

“Also in Iloilo guests come and have a lot of money in comparison to those in the village and thus, they can buy fertile land, they come and stay for certain years, they become members of the village but did not inherit land here, most of them employ people to work on the farm, people coming from outside are a problem because villagers don’t get the fertile land if somebody is selling.” (Net map, Iloilo, 19.02.2014)

In contrast in Ilakala farmers mentioned:

Man:

“We welcome them because they are also just people trying to make their lives better. We have a lot of land available and as long as they are following the rules and regulations, it’s not a problem.” (Net map, Ilakala, 18.03.2014)

In Changarawe a lot of people migrate to the village because of its good conditions for vegetable farming:

Man:

“Those settlers they are coming here to do vegetable cultivation around the banks of the river. They rent some area but there are those who are lucky and earned more income and were able to buy area. And there are those that fail to gain more income. They move out of the village again.” (Net map, Changarawe, 03.04.2014)

Changarawe and Ilakala are villages that are well familiar with immigrants coming to the village because the majority of the people migrated to those villages to work in the former sisal estate. After independence, the estate closed but some families stayed to build a living from crop farming. Nevertheless, pastoralist immigrants are not accepted by the population. Most likely due to its marginal conditions in infrastructure and climate, immigrants in Idifu are rather scarce. They encompass governmental workers that were sent to the village and that are able to rent fertile land (Net map, women, Idifu, 30.01.2014).

The identified categories of table 15 in this form hold true for all CSS. Assumptions on the interrelations with resource endowment will be assessed in the following chapter 4.2. Further research is needed to differentiate these sections more clearly and to add further attributes. This will be important to evaluate innovation adoption decisions more precisely.

4.2 Agricultural resources

Physical resources are internal to a farming system. They refer to land, labor and the various forms of capital, including financial resources, buildings, machinery etc. or non-physical resources like know-how and skills or personalities, contacts and formal and informal social organizational structures among members of the farm system (J.L. Dillon, 1992). The agricultural systems in the CSS are low external input systems. Therefore, the resources of major importance for the system and that correspondingly

need to be looked at more closely, are those internal to the system. In classical economics they are also called the primary factors of production: labor, land and capital. In this chapter these resources shall not only be discussed in physical terms but also in terms of their interrelations and non-physical dimensions for different subgroups of farmers, as identified in point 4.1.

Furthermore, understanding the resource dimensions and inter-linkages will then set the background to understand problems and limitations that people face in agriculture, which are summarized in chapter 4.3. However, limitations in resources, access and availability of them can already constitute a problem in itself, as they may limit, or even harm the agricultural output. Especially those factors limiting current production shall be highlighted. In the last section, differences for different subgroups of farmers as well as for different villages will be indicated.

4.2.1 Labor

The following section discussed sources of labor for the system, how tasks are divided, which restrictions people face and how additional labor in the form of help can be generated. Results were mainly generated with the help of the tools net map, seasonal calendar and tools for livelihood analysis.

For the majority of the farming systems in the CSS, labor is provided by the inner family meaning in the “ideal” case a man, a woman and to a certain extent, also children. What can be realized on the farm depends a lot on the household’s work force and how much can be done in a given time. Labor demand depends on the size of the farms as well as on the possibility of families to use assisting farming tools such as tractors or oxen. This possibility is available if people own the mentioned equipment or are financially able to rent the equipment. In general, labor demand peaks are land preparation, seeding, weeding and harvest for crop cultivation and pasturing ruminants. In Changarawe, it was reported that many families are able to afford the rent for a tractor for land preparation. In other CSS the use of tractor or oxen was limited to a small number of HH because of costs involved.

The participants in all CSS stressed that men and women are involved almost equally in the work, with most activities conducted together, excepting small differentiations that are listed in Table 16.

Table 16 Gendered activities in agriculture and the household

Men(m)/ Women (w)	Crop/ livestock, activity	Description/Quote	Region	Source
m		The land is chosen by men	All	Ilakala Interview, 24.03.2014
m	Field preparation	If it is a new piece of land men prepare the field	All	Crop calender, Ilakala, 25.03.2014; Crop calender, Changarawe, 07.04.2014; Net mapwomen, Ilakala, 18.03.2014
w	Field preparation	Land preparation ("kubelega") done by women	All	Feedback, Idifu, 22.04.2014; Net map women, Ilolo,19.02.2014; Net map women, Ilakala,18.03.2014
m	Seeding	Plowing	All	Net map women, Idifu, 30.01.2014
w	Seeding	Drilling the seed	All	Net map women, Idifu, 30.01.2014
w	Equipment	<i>"Men use the ox hoe while women are supposed to use the hand hoe."</i>	Dodoma	Problem tree crop, women, Idifu, 30.01.2014
m	Pesticides	Buying and application of pesticide	All	Livelihood 1 women, Ilakala, 15.03.2014
w	Tools	Do not own oxen, other animals or a bicycle	Dodoma	Net map women, Ilolo, 19.02.2014
m	Rice	Preparation of rice nursery	Idifu	Crop calender, Idifu, 10.02.2014
m	Rice	<i>"For rice crops men are engaged more than women, because it is hard work"</i>	Idifu	Problem tree crop men, Idifu, 31.01.2014
w/m	Rice	<i>"Many stages: there is pre-preparation, weeding, separating the rice and residues. A man cannot separate rice and residues. A man can only help you to slash and harvest. He can neither fill the empty places when the rice is still young. For all those things a woman is responsible."</i>	Morogoro	Livelihood 1 women, Changarawe, 01.04.2014
w	Rice	Husking	Morogoro	Livelihood 1 women, Ilakala, 15.03.2014
w	Rice	Trade	Morogoro	Livelihood 1 women, Ilakala, 15.03.2015
w	Groundnut	Special for women	Morogoro	Livelihood 1 women, Ilakala, 15.03.2016
w	Groundnut	Removing residuals	All	Crop calender, Idifu, 10.02.2014
m	Maize	Seeding: preparation of rows and holes: <i>"men do it because women cannot do it straight"</i>	All	Crop calender, Changarawe, 07.04.2014
w	Maize	Harvesting: <i>"If you have a large area to harvest men would rather employ other people to help them, then harvesting themselves"</i>	Morogoro	Crop calender, Ilakala, 19.03.2014 ; Crop calender, Changarawe, 07.04.2014
m	Maize	Transport of harvest home by bicycle	All	Crop calender, Ilakala, 19.03.2014; Problem tree crop men, Ilakala, 20.03.2014; Crop calender, Changarawe, 07.04.2014
m	Maize	Driving away monkeys from the field	Morogoro	Problem tree crop men, Ilakala, 20.03.2014
m	Sesame	Preferred by men	Morogoro	Livelihood 1 women, Ilakala, 15.03.2014
m	Sesame	Application of pesticides	All	Crop calender, Ilakala, 19.03.2014; Problem tree crop women, Ilakala, 21.03.2014
w	Sesame	Cleaning the sesame at the field	Morogoro	Crop calender, Changarawe, 07.04.2014
m	Millet	Threshing	Dodoma	Crop calender, Idifu, 10.02.2014
w	Millet	Removing residuals	Dodoma	Crop calender, Idifu, 10.02.2014
w	Bambara nuts		Dodoma	Net map women, Ilolo, 19.02.2014
m	Vegetables	Irrigation	All	Crop calender, Ilolo, 21.02.2014
m	Trade	Engagement as trader	All	Livelihood 1 women, Idifu,24.02.2014; Net map women, Changarawe, 03.04.2014

4.2 Agricultural resources

Men(m)/ Women (w)	Crop/ livestock, activity	Description/Quote	Region	Source
m	Livestock	Shelter preparation, buying of fodder, slaughtering	All	Livestock calender, Ilolo, 21.02.2014; Net map women, Ilolo, 19.02.2014; Livestock calender, Idifu, 13.02.2014
m	Medication	<i>"My son is the one who makes follow up.He went to the extension officer who gave him a medicine. He came back home and we gave it to the chicken and they recovered."</i>	All	Problem tree livestock women, Ilakala, 22.03.2014
m	Ruminants	Pasture, selling	All	Livelihood 1 men, Idifu, 05.02.2014; Livestock calender, Ilakala, 24.03.2014; ; Problem tree livestock men, Ilolo, 20.02.2014
w	Ruminants	Milking	All	Livestock calender, Ilakala, 24.03.2014
w	Chicken, pigs	Taking care, feeding	All	Livelihood 1 women, Changarawe, 01.04.2014; Livestock calender, Idifu, 13.02.2014
w	Household	<i>"The majority of women are the ones to fetch water, 1 out of 10 men might fetch the water for the family. If you are very tired you might ask someone and pay him for bringing water."</i>	All	Problem tree crop women, Ilakala, 21.03.2014
w	Household	To sweep, cook,collect firewood,fetch water,prepare bathing water	All	Net map women, Ilakala, 18.03.2014
w	Household	<i>"When women come back from the farm they also have to collect and bring back the firewood, while man just work on the farm and go home, women have to carry the baby and fire wood and the hand hoe."</i>	All	Problem tree crop women, Idifu, 31.01.2014

Despite claims of participants that men and women share tasks in agriculture, table 16 is illustrating that in general women are more engaged with food crops while men are well informed about cash crops and related trade issues. Furthermore, men tend to take over all those jobs that involve the use of external inputs or farming equipment other than the hand hoe such as ox hoes and pesticide applicators. Men are as well the owners of these tools or otherwise, are responsible to rent them if necessary. Women are especially responsible for time consuming activities such as land preparation or husking of rice. Farm work times for Christians are every day except of Sunday. For Muslims, Friday is the free day. People usually start very early in the morning. Women often either stay in fields around the homestead or may come back for lunch time to prepare food for the children. Usual finishing time is around two or three in the afternoon. After farming, women continue with household responsibilities.

High value livestock keeping is rather considered a man's field of work. Women are only responsible for those activities that can be conducted around the home stead. Those include feeding animals or milking ruminants.

In all CSS, traditional gender roles are ostensibly accepted by both, men and women. If a woman or a man lives alone, they rather hire someone to help her or him with typical 'male' or 'female' activities than to do it themselves. An example is given in table 16 concerning the harvest of maize for which men would rather hire someone than to do it themselves. Also for livestock it was mentioned:

Woman:

“Question: I am not married; can I be able to keep pigs?”

Answer: Yes you can.

Question: Who will construct the stable?”

Answer: You just pay a man to build the stable for you.”

(Livestock calendar pigs, Ilolo, 21.02.2014)

It is interesting that in Morogoro CSS, rice as a labor demanding crop is commonly farmed more by women, while in Idifu, Dodoma rather men are engaged in rice cultivation (compare table 16), most likely due to its currentness of introduction to the village and the demand of a tractor for preparation.

Children start to get involved into farming practices between the ages of seven to ten years. Participants explained that children only help on the farms on weekends or holidays when there is no school. They can help, according to their physical capacities and overall spend less time in fields than their parents. During December, the school is closed so especially during that time, children help with the preparation of the farms (Net map, Ilolo, women, 19.02.2014). They are excluded from hard work such as preparation of farms with long grasses and trees or the long transport of the harvest home (Net map, Ilakala, women, 18.03.2014). Children, who finished school but who are still unmarried are an additional full labor source for the family farm. Whenever someone is marrying, he or she is leaving the family and starts to build an own farm together with his wife or her husband.

If a woman gets divorced, children stay with the mother until they are at least seven years old, after which they may be allowed to live with the father and to assist him. This has the reason that:

“Children can take care of themselves and could report any mistreatment by the step mother, because the father will be married to another woman.” (Net map, Changarawe, women, 03.04.014)

In regard to single female households, it was reported that they are highly constrained in labor. No man in the house for them means:

“When you are two you do big projects for development but when you are alone you cannot.” (Net map, Changarawe, women, 03.04.2014)

Farming as well as household responsibilities and the raising of children are all allocated to women. Concerning cash crop farming, participants explained:

“What is hindering women from engaging in cash crops is the lack of money. They are either divorced or widows, so due to that she already has problems and she will struggle in order to at least farm a small portion for food and money to send children to school. Women have many responsibilities, many things to do before going to the farm.” (Feedback, Ilakala, 16.04.2014)

In all CSS, the number of single female HH is much higher than that of male single HH. This is due to the fact that men, after getting divorced or becoming a widow, often marry again. But women who already have children, in many cases stay alone because no man wants to afford the cost for children of another man.

Woman:

"I am a widow with six kids, so I couldn't get another husband. The problem is he finds out you have six children. So he says. 'it means this is six acres, so you and me, eight acres. I can't handle this'." (Net map, Ilakala, 18.03.2014)

Many single women go back to their parents after getting divorced or becoming a widow. Parents in general were named as the number one source of help in times of need. Nevertheless, help on farms by extended family members seems to be a rather rare case. During the feedback in Idifu, participants stressed again *"as soon as you marry, farming activities get separated"* (Feedback, Idifu, 22.04.2014).

In Changarawe women claimed:

"There are only your children that can help you on the farm. There is nothing for free these days." (Net map, women, Changarawe, 03.04.2014)

Especially older parents can barely manage to farm on their own plots, hence, rather depend on the help of their children than the other way round. But help for the old is rare in these days. In interviews with people older than 65 in Idifu as well as in Ilakala, they reported:

"During our times, the family ties were very strong. We assisted the old ones and respected them. Today our children cannot assist us because they have their own challenges. Now everybody is on its own and concentrated on his own inner family." (Interview, Idifu, 14.02.2014)

"It is hard because we used our own energy to farm and our energies are failing us now because of our age. Farming is becoming hard to us now." (Interview, Idifu, 14.02.2014)

However, generalizing at this point is hard to do because situations and relations among family members may be different in each individual case. What was made clear by the elder farmers was that help relations mainly depend on the economic status of the children.

If families do need help on their farms, a typical procedure in Dodoma CSS is to invite fellow farmers to help on the farm one day and afterwards you provide them with "Pombe" and/or food called "cande" (Mix of beans, maize and bambara nuts) (Livelihood 2 men, Idifu, 11.02.2014). In Morogoro CSS, this is common as well, although since the amount of Muslims in the villages is higher and they do not drink alcohol, people rather prepare only food. There it is called "Kiwili" (Livelihood 1 men, Ilakala, 15.03.2014). Otherwise, those who can afford invite wage labor to get assistance with farming activities.

However, organization for herding ruminants in Dodoma is interestingly sometimes organized in groups. During a livestock calendar session in Idifu, participants explained:

“When we want to go for pasture away from home, we join our herds together and make a larger herd. Then we go to the areas together. But there we make a timetable. In times some of us can come back to their families and some will look after the cattle and after vise versa.” (Livestock calendar, Idifu, 12.02.2014)

Men and children are the ones who take the herds to pasture. A man explained:

“I can't send my wife to pasture because she has a lot of things to do at home.”

(Problem tree livestock, Ilolo, 20.02.2014)

In relation with crop farming activities, group work or collective activities are not common. They are not a key survival strategy. In all CSS, there are different initiatives, although yet not very popular among villagers. The village with the highest number of farmer groups was Ilolo.

About the work in groups members appreciated⁷:

- Unity and safety of the group
- Education and training
- Contact with other farmers, even outside the village
- Flow of information and ideas, creativity in problem solving
- Farming activities in the group make work faster and easier
- Farmer empowerment through the group
- Platform for trade: higher quantity and better prices
- Possibility to earn money for further group activities

They saw constraints in:

- Covering running costs
- Voluntary work: takes unpaid effort and time
- Reliability of members to show up and equally fulfill responsibilities
- Trustworthiness of leaders (especially in relation with money)

Summarizing, one can realize that most work is entailed on the individual adult men and women of a family. Most farming activities are conducted together, but men take over responsibility for all those activities that entail the spending or earning of money. Help with farm work is uncommon. Therefore, only those who can afford to pay laborers can manage to farm on bigger plots than their family labor source would allow.

4.2.2 Land

This section illustrates which forms of land tenure are available, which restrictions and differences exist among the CSS and how participants evaluated the quality of the village land. The resource 'land' basically covers all natural resources available,

⁷ Source: Interview farmer groups, Ilolo, 22.02.2014; Interview women farmer group, Idifu, 06.02.2014; Interview farmer group, Ilakala, 22.03.2014; Interview vegetable farmer group, Changarawe, 08.04.2014; Livelihood 1 women, Changarawe, 01.04.2014

meaning not only the arable land as such but also water resources, forest resources or others that may in a direct or indirect way contribute to agriculture.

Land tenure

In Dodoma CSS, land is inherited over a long chain of generations. Gogo people are staying in the region already since pre-independence time. With independence, the new president Nyerere announced the “villagization” program in the 1970s. People gathered together in central villages. Nevertheless, people kept their original farm land. This led to the situation that farmers sometimes have to travel long distances in order to reach their old farms even outside the village borders. As people older than 65 reported during an interview in Idifu, people still keep this land for further use. Because of that, not only arrival but also the transport of the harvest back home can take a lot of time and effort.

Many of the older farmers are still farming on those pieces of land. Others who already died passed it to their children. After death, people explained that usually both, female and male children get pieces of the parent’s farm. Nevertheless, already before death it is common that sons of the family get a piece of land when they get married. This is not happening for girls. Girls get married into another family. She leaves her parents’ farm and starts farming on the other family’s farm:

Woman:

“I had my farm at our home and when I got married my husband showed me where to farm.” (Net map, Changarawe, 03.04.2014)

This holds true for almost all HH in the Dodoma region, although tradition is about to change. In Morogoro, it depends on the tradition of different tribes. For some tribes it is the case that sons and daughters can inherit land equally so also a wife can bring own land into a marriage (Livelihood 1 women, Ilakala, 15.03.2014). Therefore, different women were reporting different stories in Ilakala as well as in Changarwe.

In general in the Morogoro CSS, the chain of inheritance for land inside the village is shorter because of a high percentage of immigration due to the attractive work for the sisal estate of former years. However, also here farmers may as well keep or inherit former family plots outside the village in the places where their ancestors used to come from. After closing the estate those people who stayed, started to engage into crop farming even more. People in those years just picked a piece of land as they preferred. During a discussion in Ilakala, men were explaining:

“We were looking for attractive land. For choosing you had to decide. For example you looked at the hill and thought ‘under that hill it might be very nice, let me see if the land is good.’ Even during dry season, when you tried to pull in a stick the earth was so soft. You shall plant in an area with a lot of mountains that attract rain. You may have stayed for a day and others told you there is a lot of rain in that area.” (Interview people older than 65 years, Ilakala, 24.03.2014)

In Ilakala, part of the area is still owned by the former sisal estate. Nevertheless, this did not seem to constitute a severe problem for the villagers as it was expressed that *“there is enough land available in the village”* (Net map men, Ilakala, 18.03.2014).

In Changarwe this situation is very different. Land scarcity and insecurity was named as one of the number one problems in the village. In 2011, two acres of former estate land were given to HH with the condition that only annual plants are grown. The land is not yet secure and can be taken from farmers at any time by the estate owner. Participants explained about the procedure to obtain these two acres:

Woman:

“When the farms were divided some of us were told to get a share from our parents, others were absent that day. The land was only for 300 families. All land is already given.” (Net map, Changarawe, 03.04.2014)

Person:

“In Lugunga nobody received the two acres of land.” (Feedback, Changarawe, 17.04.2014,)

Hence, unmarried young people still living with their parents as well as the majority of inhabitants of Lugunga and Dinima sub village were excluded. In fact, especially in those two sub villages land scarcity is severe. People especially used to farm on a fertile area nearby the sub village, which is owned by a big agricultural enterprise from outside the village. Only in 2013, the owner decided to farm on this land himself. Because a lot of surrounding area is unfertile sandy soil people who do not keep other fertile farms outside the village are forced to rent portions of land in other sub villages. Participants reported that prices for rent accordingly have increased from 20 000Tsh per acre and farming period in 2013 to 30 000/40 000Tsh in 2014 (Problem tree crop women, Changarawe, 04.04.2014). This dependency on renting land is creating high capital demand in the sub village. Farmers commented that they have to sell the bigger part of their harvest to afford the rent:

“We need to sell our output in order to be able to pay for the rent of land in the next season. That is why a big portion of the harvest is for selling. Everything depends on maize.” (Problem tree crop women, Changarawe, 04.04.2014)

“We are very poor, we lack land for cultivation and even for settlement. And that is the main constraint in our two sub villages Dinima and Lugunga.” (Net map men, Changarawe, 03.04.2014)

Poor farmers occupy surrounding land without land title but the land was reported to be sandy and unfertile.

In all CSS, due to inheritance some HH were already called “naturally rich” because they received fertile land that was generating a high output (Net map men, Changarawe, 03.04.2014). In families with many children, if land is inherited equally, plot sizes that can be inherited are rather small. Depending on the capital stock the

young couple is able to build, there are different options to acquire additional land to increase farming activities and especially to get more fertile land. Buying land has the highest demand on immediate capital available. In general disposable land is not as available as land for rent. The higher fertility the higher prices of a plot. Same holds true for renting land although immediate capital demand is less.

For those renting land in Changarawe, it was reported:

Man:

“Those who rent might not have capital or capacity to farm the whole land, so maybe they rent one acre and one acre they will farm themselves. It is mainly low capital which is keeping people to farm on two acres, or like one man he is old and cannot afford to farm on both, or the same person does not have enough to eat for the family so he has to do casual labor for someone and at the same time he cannot do work on his own land so he will rent while continuing doing other things.” (Problem tree crop, Changarawe, 04.04.2014)

Man (about land next to the river):

“Those that rent, they cultivate vegetables. But we don’t cultivate ourselves there because we don’t have enough inputs like chemicals, water pumps and fertilizer.” (Net map, Changarawe, 03.04.2014)

Summing up, people rent out their land because: they are not living in the village but want to keep the inherited plots; they cannot afford the necessary tools or inputs to use the plots efficiently (especially for vegetable cultivation, Changarawe); they own more land than they are able to farm (especially older farmers) or they are in need of instant money. Across the farming season, renting out land is less lucrative than farming it, so of the last three points limitations must be very strong to decide to rather rent land.

Man:

“There are two types of land owners, there is the one that you pay the rent in advance and there is the other one you pay after harvest. But few people let you pay after harvest. The majority wants the money in advance.” (Net map, Changarawe, 03.04.2014)

Nevertheless, in Morogoro, people only rent out land for crop farming purposes. Livestock keepers in Ilakala, located in the sub village Camp, expressed that no farmer would rent land to them just as pasture area (Livestock calendar: cattle, Ilakala, 24.03.2014). They use common ground for herding ruminants. This is contributing to the conflict between pastoralist and crop farmers in the region.

The man of the family decides whether to buy or to rent land, as well as which and where to rent or to buy land. If the father of the household dies the land is going over to the widow. This is different if couples separate and divorce. When getting married, the woman is welcomed to the husband’s family most often without any own property. As she arrives she is also leaving the family. It was reported that in most cases after divorce, no own land or property is attributed to the woman, even if acquired together during time of marriage and although the women have legal rights and in principal

could go to court to demand their property. Many women just go back to their parents and help them on the farm to start a new living.

Man:

“After you get divorced you come back without any farm. Your parents are the ones who will give you land. You cannot get anything from your husband.” (Problem tree crop, Ilolo, 18.02.2014)

Only in Morogoro, for some few cases it was reported that property was shared after divorce. If a woman already brought land or wealth into the marriage after divorce she can take back those things for herself. Otherwise, at least a part of land can be as well already attributed to the common children.

Woman:

“If you had your own piece of land before divorce you can just get back to that piece. But if you maybe bought a piece together during marriage and did everything together, there are two types of men: one may just chase you away without giving you any plot. The other one may give you at least one or two acres, but the rest remains with him, and sometimes if you have children he tells you: ‘this piece will stay for the children’, and the woman has to go and start new. A high percentage of women are just chased away without anything.” (Net map, Ilakala, 18.03.2014)

Land features

Among the CSS, land features making land more or less attractive are very different.

During the resource map session in Idifu, people were explaining that inside the central village there are mainly sandy soils with low fertility that are used for home gardens. Outside the inner village border to the south west there are red soils, which are good to grow grapes, groundnut and sesame but also millet. To the east, people grow a lot of pearl millet.

Woman:

“Clay soil contains a lot of water and is good for rice cultivation. In the sandy soils there are only small farms but in the red soil farms are bigger.” (Net map, Idifu, 30.01.2014)

“People living in areas with black soil are more successful in farming compared to others. They also grow many different crops there.” (Feedback, Idifu, 22.04.2014)

In Ilolo, people were complaining about low land fertility after having been farming on the land for many years.

Man:

“The farms are available but they are not fertile. Because you find that the same farm has been used for so long. So you may rent a large farm but you still get less output.” (Problem tree crop, Ilolo, 18.02.2014)

In both Dodoma CSS, there is a very fertile wetland that allows for two farming seasons per year and lucrative vegetable production in the usually semi-arid Dodoma region.

Man:

“Getting a piece of wetland might allow you to overcome problems by farming vegetables.” (Net map, Iloilo, 19.02.2014)

The Iloilo, the wetland is bigger than the one from Idifu. The wetland in Idifu is surrounding the whole central village during the rainy season like a natural barrier as can be seen in the map in figure 10.

About availability of this land in Iloilo farmers were reporting:

Man:

“The whole area may reach 600 acres, but we have very small plots. Nobody has one complete acre in one area.” (Problem tree crop, Iloilo, 18.02.2014)

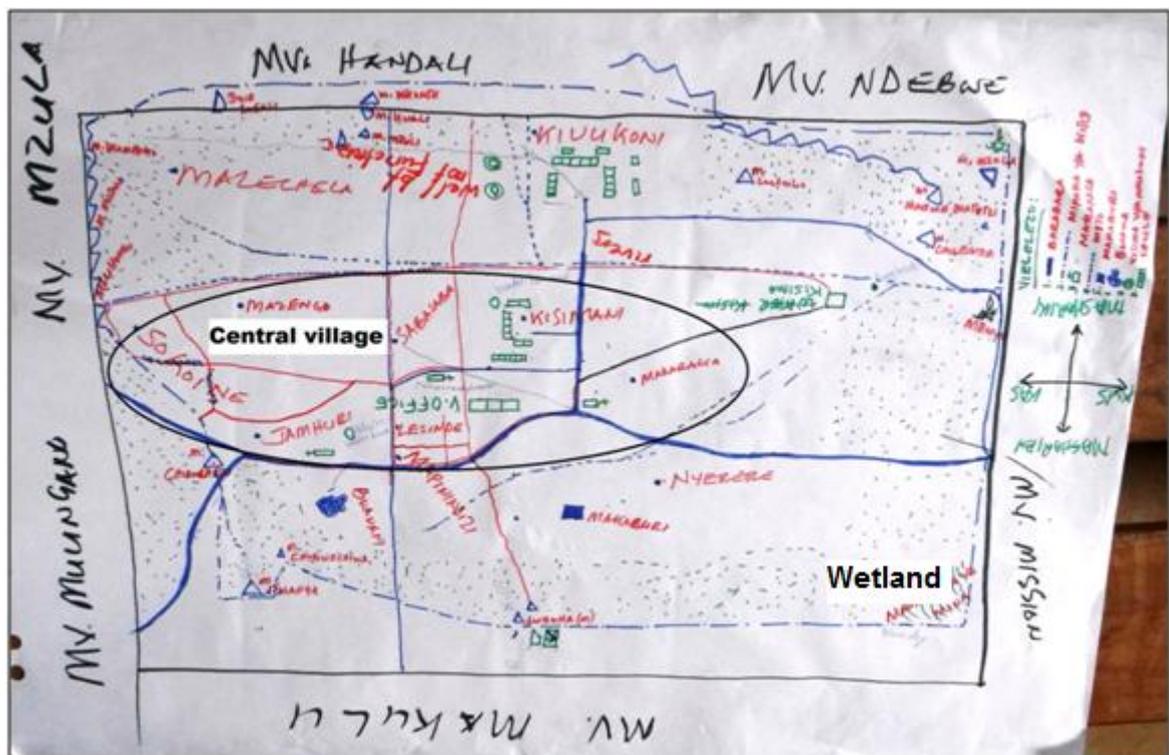


Figure 8 Resource map, Iloilo, 21.02.2014



Figure 9 Wetland Iloilo, sugarcane harvest (source: M. Höhne, photo)

As the researcher observed in Iloilo, farmers grow e.g. maize, sugarcane fruit trees and vegetables (e.g. tomatoes, Chinese cabbage, pepper) in the wetland.

In Idifu, properties of the south wetland are different than those of the north wetland. Therefore, the area to the south is frequently used to grow rice and vegetables such as tomatoes. In the wetland to the north, only little rice is grown but rather millet. As well common wetland land is very often used for grazing and watering ruminants as long as enough grass is available in those areas (compare figure 11).

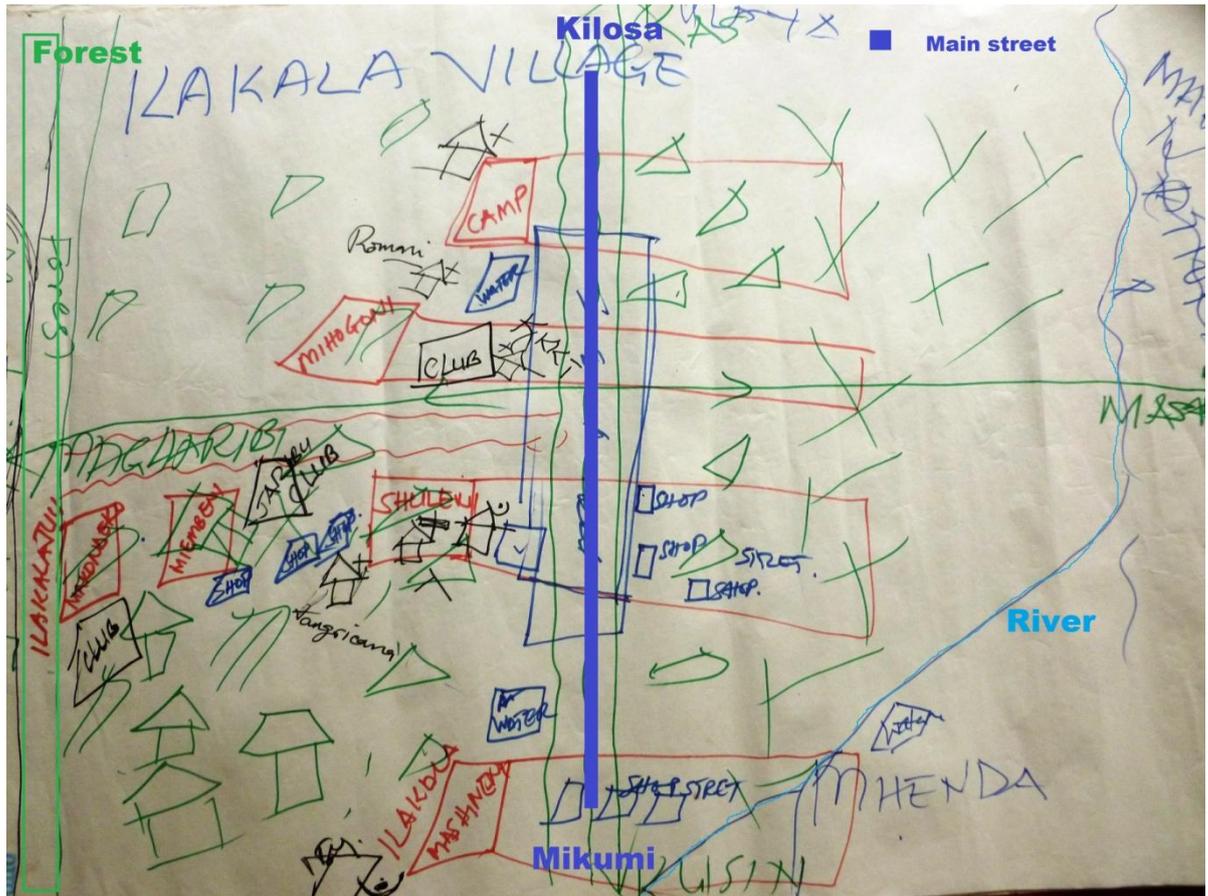


Figure 12 Resource map, Ilakala, 14.03.2014

During the resource map session, participants explained that most people live to the east of the main street, direction forest (compare figure 12). In this area, also more cultivation is taking place. Towards the west and river side, a lot of sesame is cultivated. Farmers in Ilakala were reporting about the different qualities of land due to slopes:

Person:

"Those in the valley, the small amount of rain will make them get something. But those up the hills they may get nothing, not even one bowl of maize." (Interview older than 65 years, Ilakala, 24.03.2015)

Man:

"Many people cultivate on a slope but when it rains the fertile part is taken down." (Problem tree crop, Ilakala, 20.03.2014)

On the slope, people mainly cultivate millet, sesame or bambara nuts because they are more drought resistant than maize. Wildlife of the nearby forest and national park is disturbing the farmers: Monkeys are destroying the maize fields and hyenas once in a while disturb livestock. Nevertheless, the forest area at the edges to the east was preserved as village reserve. It is nowadays used for bee keeping. Protection from deforestation seems to be important for farmers. They expressed problems due to deforestation:

“At first we didn’t have the water problem. We had trees and forest so all water could be conserved somewhere. But like 5 years ago it became a problem. People were the ones who destroyed the water sources by themselves.” (Problem tree crop men, Ilakala, 20.03.2014)

The problem of quality water scarcity in Ilakala is especially strong in the sub village of Makondeko. This creates household problems that as well affect farming activities:

Man:

“It affects the agricultural activities a lot, because if you wake up in the morning and there is no water in the house you will have to wake up very early to go where there is water to fetch water for home consumption, but by that time you could have also already been in your farm working but you waste your time just to fetch water.” (Problem tree crop, Ilakala, 20.03.2014)

Changarawe is located in a less hilly area than Ilakala. Nevertheless, also here farmers reported about the different qualities of land due to slopes. At the end of the researchers stay in the village, some parts of the village center and nearby the river were flooded after heavy rainfall, to which did not only fall victim the harvest of many farmers but also their homes.

Despite this experience, Changarawe was expressed to be an attractive village because of its fertile land for vegetable cultivation nearby the river. Obtaining land there is difficult and expensive. Owners prefer to rent out rather than to sell. Those who stay and farm vegetables effectively are reported to be those that can afford inputs and equipment. Vegetable farmers were reported to be major employers for wage labor. Apart from those fertile areas near the river and those owned by the sisal estate, many other parts of the village were reported to be sandy and less fertile.

Summarizing, farm land is forming the basis for any agricultural activity. Already by inheritance, it can render a person to be rich or poor by determining agricultural output and hence, income by fertility and size. Women are in general more constrained in obtaining adequate land. In all CSS, land fertility was claimed to be a major constraint for production. Land scarcity is the most prevailing problem in Changarawe.

4.2.3 Capital

This section identifies main constant sources of capital for agricultural activities as well as additional sources of income for ad hoc problem solving. It shall then be revealed how household capital is spent, apart from on farming, to illustrate the importance of agriculture in terms of capital demand.

The major source of capital for farming in most cases comes from income out of farming activities of the last season. For those who keep high value livestock, this also generates a remarkable capital contribution. The income from farming depends on the one hand on the quantity of output obtained, as well as on the other hand, on the market and price situation when selling the harvest. The quantity of harvest depends

again on several other factors that shall be explained in more detail in part 4.3. Income from agricultural output is mainly obtained right after harvest. In Morogoro, participants explained that: “*The season that starts from June and July to October and November is good*” in terms of income (Livelihood 1, women, Changarawe, 01.04.2014). Additional sources of income are those activities revealed in part 4.1, with varying financial output and reliability. Income from agriculture was reported to become increasingly insecure, which is making the farming system more vulnerable. Problems leading to this insecurity will be explained in point 4.3.

Man:

“Farmers sell the majority of the agricultural harvest and only put aside a bit for food. Even if they put aside more for food it does not reach the next season. Sometimes, we have to buy additional food. You have to pay everything from the output: the hospital etc. Everything depends on the agricultural output. In the end it will not be enough neither for food nor for income.” (Problems crop, Changarawe, 04.04.2014)

Capital in agriculture is needed to purchase or rent certain assets and thereby, facilitating productivity enhancing activities. Those can be sorted into regular expenses (e.g. rent of a tractor for land preparation) as well as into ad hoc problem solving expenses in farming (e.g. pesticides) and livestock keeping (e.g. medicine). Expenses differ among the regions. In Dodoma region, the most frequently mentioned expenses included renting or owning an ox for farm preparation, purchasing manure, renting or owning an oxen cart for transportation and purchasing livestock medication if needed. In Morogoro, most frequently mentioned expenses included renting a tractor for farm preparation, renting of bicycles or motorcycles for transportation, purchasing livestock medication and purchasing pesticides and pesticide applicators for sesame and herbicides for rice. In all villages, people were demanding high quality seeds. Many participants in all CSS mentioned that they have difficulties in covering these input costs.

Man:

“The problem is not to get that chemical but the money to buy that chemical.” (Livelihood 2, Changarawe, 02.04.2014)

Man:

“We don’t have the power to buy an ox hoe and this makes us unsuccessful.” (Problem tree crop, Ilolo, 18.02.2014)

If equipment for preparation has to be rented this creates an additional problem: one is dependent upon others.

Man:

“Most people don’t have an ox hoe so they have to wait in the long chain, but then the rain comes and when you reach the ox hoe, the rain is already cut off, that’s a problem.” (Problem tree crop, Ilolo, 18.02.2014)

The lack of capital is especially critical as people are unable to intervene in moments of need, such as attacks of pests and diseases on crops and animals, which forces them to basically watch their output decreasing.

Participants were furthermore complaining about increasing costs but also decreasing prices for their produce:

“Everything is expensive: the tractor, the pesticides. Last year one bag of maize was 100000Tsh, now it is 20 000Tsh. Now how many bags are you going to sell to afford the money?” (Problem tree crop, Changarawe, 04.04.2014)

In all CSS, vegetable cultivation incurred costs to buy or rent high value fertile land, to buy pesticides and to organize for irrigation.

During sessions in all CSS, participants expressed a high demand for capital intensive farming tools and external inputs. It is partly due to their observation of other rich and successful farmers that they equate developed agriculture with capital intensive high input farming because those farmers always get a high output while poor farmers suffer. Those experiences are justifying the demand of the farmers in the face of an increasingly insecure environment when there is need to buffer effects of such.

The capital obtained from all household activities does not only need to be enough to cover farming expenses but also to satisfy all HH needs such as the payment of school expenses or the purchase of clothes, soap, salt or side dishes. It should also generate small savings because otherwise emergency cases are always interrupting the family capital planning. Situations when people need to go to the hospital and need to buy medicine for household members or livestock were frequently named as examples. To solve urgent problems there are various strategies to obtain immediate income. The first thing is to realize if the HH has any assets that can be sold.

“If you are in need of money for those who keep livestock, the first thing to do would be to sell livestock. Others need alternatives like selling other things such as food or a portion of land.” (Feedback, Iloilo, 19.04.2014)

As mentioned before, livestock is a capital and serves as economic fall back for times in need; hence, is the first thing to be sold if money is needed. The next step can be to sell certain household items or parts of the food storage. Social structures also allow for financial help among fellow farmers. Nevertheless, borrowing money did not seem to be popular among participants due to bad experiences when asking back money. Therefore, people reported to often agree with each other in the form of a contract fixing date, rate or form of repayment.

Woman:

“We borrow from one another. [...] At these times it is not good to lend money. These days you must have a signed agreement with witness and state clearly how much money to borrow and the date to return it with interest rate.” (Net map, Changarawe, 03.04.2014)

Money can as well be paid back in form of food or labor. It is usual that these contracts also include an interest rate. Interest rates for these informal credits are in most cases very high, often reaching the double of money borrowed. In Idifu, a famous source of such credits is the local big trader. About his credits it was mentioned:

“The disadvantage is that sometimes if you are in need of money like 5000Tsh he will give it to you and the repayment will be after harvest. But then he will double the price and payback will be already 10 000Tsh.” (Feedback, Idifu, 22.04.2014)

In all villages, community banks (VICOBA) are established. They are organized as credit groups. People need to pay a certain fee to become member and afterwards pay a weekly or monthly fee to be allowed to get small credits from the VICOBA. Sometimes membership also depends on other members' evaluation of a person's trustworthiness, as explained in Iloilo. Amount of credit is related to the amount of deposit and needs to be paid back with a reasonable interest rate within an agreed time frame. Nevertheless, members of such groups reported that repayment remains a problem due to low enforcement power. For non-members of such groups mainly the entrance fee as well as the fixed monthly deposit was named as obstacles to get a membership.

“Only few people are members of the VICOBA, because not all people can contribute money every week and they are afraid of discussions with their fellows if they don't have the money. Per week one has to contribute between 1500 to 3500 Tsh.” (Feedback, Changarawe, 17.04.2014)

This is excluding the most poor from reasonable micro credits within the village. The remaining option to generate capital for urgent farm demands is wage labor.

Typically all capital in the male headed family belongs to the man. He is the one responsible for trade hence, also receiving the money. Men are making final decisions about the spending of the money. In Dodoma CSS, the women take over the function of treasurers, when keeping the family money. In Morogoro CSS, different things were reported but most often with men being treasurers and decision makers at once. This led to different HH problems in some Morogoro families. Women were reporting about the misuse of family income by their husbands:

Woman:

“In the majority of the homes, if a child is sick and you ask the husband: ‘Where is the money we saved?’ he will ask: ‘Which money?’ And he leaves doing his own things that make him happy like drinking.” (Net map, Changarawe, 03.04.2014)

Women were expressing the need to keep own secret savings, not only for personal needs but also to be able to intervene in family problem situations when the husband is not able or willing to support his family. Women developed strategies to gather money behind the back of their husband:

Woman:

"We are saving. Because most of the men do not harvest maize so in this period you can save some money." (Livelihood 1, Changarawe, 01.04.2014)

Woman:

"It depends with the season but if it is the season to sell sesame you can steal a portion, sell it and keep the money. In emergency cases the money you obtain can be of much help." (Net map, Ilakala, 18.03.2014)

If there is request for a certain food item it is common that families barter. For instance in Iloilo, millet is exchanged with maize and groundnuts can be exchanged with bambara nuts (Feedback, Iloilo, 19.04.2014). Instead of paying with money in Idifu, it was also possible to exchange e.g. millet for soap or sugar at the shop (Feedback, Idifu, 22.04.2014). Many single women at least try to help each other in exchanging food items. Single women reported to lack sources of financial help:

Woman:

"Partners they can help each other, share ideas and problems will get solved. A man can just go to another man to borrow money, but as a woman you may go to your fellow women to ask for money but she neither has money: 'I am just as poor as you'." (Net map women, Ilakala, 18.03.2014)

Summarizing, the respective capital stock is mainly determined by the last farming season. It is determining in how far farmers can purchase or rent assisting tools or inputs. The demand for those is increasing with increasingly less predictable environmental conditions. The ability to make use of those tools or inputs is a frequent criterion for farmers to differentiate each other into rich and poor. Credit options for those in need are few. Availability or access to capital is better for men.

4.2.4 Resource limitations: a summary

This chapter revealed which resource constraints and opportunities people face in the CSS. This situation creates the frame in which farming activities take place in the CSS. As resource limitations can create a limitation for the uptake of innovations and need to be considered when designing innovations, this section shall summarize major resource limitations for different subgroups of farmers, as identified in section 4.1 in different regions in table 17. General problems are valid for all subgroups of farmers in all CSS. If any specific problem was identified for a certain group during the discussion it is indicated in the table.

Table 17 Resource limitations for different farmers

	Labor	Land	Capital
General		Soil fertility, effects of land degradation & deforestation	Increasing costs and decreasing prices, less developed credit structures with high interest rates
Men	-	-	-
Women	High workload: including household responsibilities, especially single female HH	Land tenure: inheritance and divorce patterns limit access	Married: no own capital or goods
Elderly	Physically limited	Physical limits lead to smaller areas that can be farmed, surplus land is rented out	
Rich	-	-	-
Poor	Workload: inability to rent assisting farming inputs or equipment	Inheritance, small farm size	Income dependency almost exclusively on agriculture, exclusion from local micro credits
Dodoma		Semi arid unpredictable climate	
Morogoro Villages/Sub-villages		Slopes Changarawe: land scarcity and unequal land distribution (Dinima, Lugunga); Makondeko, Ilakala: water scarcity	

Table 17 indicates that farmers did not recognize any resource limitations that are exclusive for men and rich farmers. A rich and in most cases then also male farmer can increase labor if necessary by hiring labor; he can increase farming land by renting or purchasing from others and; in times of higher financial need he can get access to micro credits from the VICOBA much easier or could liquidate e.g. livestock.

The situation of the poor is very different to this. Their labor sources are determined by the inner family. They obtain a big portion of their farming land by inheritance but may in some cases also rent additional low fertile land. Since all labor is needed for agriculture, income from other activities remains low and wage labor is only undertaken in times of urgent financial need. As many cannot afford the regular deposit for the VICOBA, they are excluded from local micro credits. Seasonal capital constraints coincide especially with the times when inputs and equipment would need to be purchased or rented. Because micro credit schemes remain underdeveloped, options of the poor to make use of external inputs and equipment in the right moment are barely given. Women suffer especially from the exclusion from key inputs and the low control over resources.

Regional differences occur mainly on the natural resource level and according to the location. In Changarawe, the probably biggest constraint for farmers is the scarcity and insecurity of fertile land. Certain assets or developments in the regions are counteracting to the given constraints. Participants recognized the benefits on labor demand when working in a group. Although groups are yet not a preferred strategy for farming, the tendency in all CSS to develop more groups is positive.

Important assets for farming are the wetlands in Dodoma and the fertile regions near the rivers in Morogoro. It remains an open question how to make best use of these assets to the benefit of the whole community.

Positive contributions to the individual capital security are made by the higher number of livestock in Dodoma and the existence of VICOBAS in all CSS. Furthermore, barter of goods is a preferred strategy by many villagers and can have positive effects as well.

4.3 Agricultural activities and collective problem assessment

The resources explained in the previous chapter create the frame in which agriculture is taking place in all CSS. Resource constraints constitute already a first limitation for production. In the following sections, steps of crop and livestock production are illustrated in the light of given resource limitations in the different CSS. Results reveal a common value chain along which various problems occur. Farmers' explanations discover, describe and connect the major problems. The value chain was chosen to illustrate problems because first: Problems occur along the whole value chain; second: Most problems rather refer to the overall steps of production than to specific crops/livestock; and third: Because the problems are often related to each other along the chain and therefore, should be studied in completeness.

4.3.1 Crop production

Crops differ among the CSS according to local settings and conditions. In accordance with the rainy season, the first farming activity starts in September at the earliest, with the preparation of the fields. The last activity ends in August at the latest, with the harvest of the last crop.

Steps of production were summarized and explained by participants using a seasonal calendar. Crops discussed in more detail were selected by the participants. Table 18 is summarizing crops discussed per village and is indicating the table of seasonal calendars for those. In all calendars, the notes highlight points that were mentioned to explain the output of the harvest for the last year or explain deviations from the farming schedule.

4.3 Agricultural activities and collective problem assessment

Table 18 Seasonal calendars: crops per village

Village	Crop	Table
Ilolo	Bullrush millet	19
	Sesame	
	Groundnut	
Idifu	Rice	20
	Groundnut	
	Bullrush millet	
	Sunflower	
	Pearl millet	
	Bambara nuts	
Ilakala	Cassava	21
	Maize	
	Sesame	
	Pigeon pea	
	Cotton	
Changarawe	Maize	22
	Sesame	

Millet is the most important staple in both Dodoma CSS and is as a drought resistant crop, well adapted to the climatic conditions of the region. There are different types of millet grown in the region. Pearl millet is popular grown for its high yields. However, it was reported that during the last planting season it was less drought resistant than other types.

Groundnut was expressed to be the most important cash crop in the region. Nevertheless, it cannot cope with drought situations as in 2013. Groundnut is often intercropped with millet.

Among the two CSS in Dodoma, rice was only farmed in Idifu. Participants explained that it is a rather new crop, introduced from other villages (Crop calendar, Idifu, 11.02.2014). Especially young men are engaged in rice farming because it is hard work and a capital intensive tractor is necessary. Due to climatic conditions in Idifu rice farming is a risky undertaking, because plants may die if water in the swamp gets less and heat is too much so that the water is basically starting to cook the plants (Crop calendar, Idifu, 11.02.2014).

Sunflower is an important oil crop in Dodoma. Farmers of both villages need to go to Mvumi mission for processing.

Bambara nuts are very drought resistant and belong to the traditional diet in the region. Nevertheless, they are only grown in small portions for home consumption because there is no market for them as participants reported.

Table 19 Ilolo, Dodoma, Seasonal calendar: Bulrush millet, sesame, groundnut

	2012 Sept	Oct	Nov	Dec	2013 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Harvest	Notes
				drought, hot sun										
Rainfall			15th			one day	1 week							
MILLET men/women	preparation of the field		seeding		weeding	weeding	growing	growing	growing	harvest w: removing residuals	harvest	storage	average	Those who started earlier with seeding got a good harvest, the ones who started late, got a bad harvest
SESAME	preparation of the field		seeding		weeding	weeding	weeding	harvest	harvest	marketing			very small	
GROUNDNUT men/women	preparation of the field		seeding	seeding	weeding	growing	harvest	harvest	drying, storage women: removing residuals				none-average	Drought

Table 20 Idifu, Dodoma, Seasonal calendar: Groundnut, Millet, Sunflower, Pearl Millet, Bambara Nuts

	2012 Sept	Oct	Nov	Dec	2013 Jan	Feb	Mar	Apr	May	Jun	Jul	Harvest	Notes
Rainfall				9th	1th	2th	x						
RICE			nursery of small plants	preparation of the field		replanting	weeding	growing	harvest			very bad	Drought
GROUNDNUT	preparation of the field			tilling & seeding	tilling and seeding	weeding	growing	harvest, drying, peeling				very bad	Drought
MILLET	preparation of the field			tilling and seeding	tilling and seeding	weeding	growing	growing	growing	harvest, threshing and separation	storage	average	
men/women only										threshing (m), removing residual (w)			
						very cold							
Rainfall			17th	x	x	x	x	x					
SUNFLOWER		preparation of the field				tilling & seeding	weeding		harvest			bad	Drought
PEARL MILLET		preparation of the field		tilling and seeding	weeding	growing	growing	growing	harvest, drying, threshing			bad - average	Not as drought resistant as other millet
BAMBARA NUT		preparation of the field			seeding	weeding	weeding	harvest, drying, storage				average	

Table 21 Ilakala, Morogoro, Seasonal calendar: cassava, maize, sesame, pigeon pea, cotton

	2012 Sept	Oct	Nov	Dec	2013 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Harvest	Notes
						hot								
Rainfall				x (before Xmas)	little		once per week	once per week						
CASSAVA	preparation of the field			planting	1. weeding		2. weeding			harvest 1			low yield	2 varieties: 2. harvest in December, no complete harvest just when you are in need of it
MAIZE		field preparation		seeding	1. weeding		2. weeding		harvest				low yield	drought
						hot								
Rainfall			x	x (first week)			x (most rain)	x	x					
Sesame	field preparation		seeding	1. weeding and reducing of some plants	2. weeding and application of pesticides		harvest, 2 weeks drying on the field						bad harvest	
				strong wind		strong sun								
Rainfall		x (2 days)	xx				15th (1 week)	x (until easter)						
PIGEON PEA	field preparation	seeding & weeding				harvest								
							field preparation	seeding & weeding		harvest			n.s.	
Rainfall			x	x (Xmas)			x							
COTTON					field preparation	seeding & 1. weeding	2. & 3. weeding & reducing side plants					harvest	average to bad	

Table 22 Changarawe, Morogoro, Seasonal calendar: maize, sesame

	2012 Sept	Oct	Nov	Dec	2013 Jan	Feb	Mar	Apr	May	Jun	Harvest	Notes
						hot						
Rainfall		x		x (some days)	x		x	x	partially			
MAIZE	field preparation			seeding	1. & 2. weeding					harvest	average	
							very hot					
Rainfall			x...x	x			xx	xx				
Sesame		field preparation		seeding	1. & 2. weeding & pesticides		harvest, 2 weeks drying on the field				average	Afraid that it won't rain again
		field preparation				seeding	1. weeding	2. weeding	harvest, 2 weeks drying on the field		average	Afraid that too many losses due to rain in March & April

4.3 Agricultural activities and collective problem assessment

Cassava used to be an important cash crop in Morogoro. With the introduction of sesame to the region, the market for cassava basically collapsed because better prices could be obtained with sesame. Nevertheless, cassava is still grown, especially by women, for home consumption and marketing within the village. It is used for business as well. Some women fry and sell cassava as a snack in the village or for students. It is a drought resistant crop and can be intercropped with maize and sesame. The farming of two different varieties allows for cassava supply almost all year round. It is only harvested if needed.

Maize is the main food crop in both Morogoro CSS. It can be intercropped with e.g. pumpkin or pigeon pea. In former years maize could be well grown in the region but due to droughts, farmers reported that during the last years, harvest of maize was low (compare table 21).

Sesame is the most important cash crop in both Morogoro CSS. It demands pesticide application. Pests occur two times, once during germination and another time during flowering. In contrast to other crops, sesame is often not stored but traded right away from the field.

In the sesame calendar of Changarawe (compare table 22) it can be observed that farmers are getting increasingly insecure about the timing of their farming activities. Some farmers already seeded in December because they were afraid that it won't rain again. Others decided for seeding only in February because they were afraid of losses due to high rainfall in March and April that may take away or destroy young plants. Both strategies in the end achieved an average harvest.

4.3.2 The crop value chain and related farmer's problems

The climate, especially the times of rain, set a time frame for when each activity should take place in order to create an optimal agricultural output. This regular farming schedule can be followed up in the seasonal calendars in tables 19, 20, 21 and 22. The calendars indicate a certain sequence of activities, which is the same for all crops. We can call it a chain of production, consisting of land preparation, followed by seeding, weeding, maturation, harvest, storage and/or marketing of crops. This chain of production is part of the overall crop value chain. As it is the part of the value chain that is rolled out by the farmers, it is setting the frame in which to analyze together with the farmers their relevant problems according to the farming activities they are undertaking.



Figure 13 Crop production: the farmer's value chain

Problems occurred throughout the whole chain of production, but with variations in occurrence and degree of problems for different regions, crops and different types of farmers. Problems and the mentioned differences will be summarized in table 23 at the end of the chapter.

4.3 Agricultural activities and collective problem assessment

Important to mention is that in all CSS, depth of problems may differ on the sub village level because all villages are very big and sub villages differ in resources, which has direct or indirect effects for the farming activities. This became especially obvious in Ilakala and its sub village Makondeko, which is far away from the main road, the school, shops and other village infrastructure. Effects were visible, as for example in that water is scarce in Makondeko because the well is far away and a lot of time has to be invested to look for drinkable water, especially during the dry season. This time is then unavailable for other (food/income generating) activities:

Man:

“It affects agricultural activities a lot, because if you wake up in the morning and there is no water in the house you will have to wake up very early to go where there is water to fetch for home consumption but by that time you could have also already been on your farm but you waste your time just to fetch water.” (Problem tree crop, Ilakala, 20.03.2014)

In the following, each step of the chain as presented shall be illustrated more in detail. Explanations for and connections among problems were mainly revealed using a problem tree. Many problems were repeatedly mentioned in all villages. Whenever a certain problem was different or stronger for a certain village, crop or farmer type this will be indicated in the text and can be followed up in table 23. Major environmental disturbance is created by drought situations as well as flooding and pests and diseases that can have effects throughout the whole chain of production and therefore will be explained separately.

4.3.2.1 Land preparation

For the land preparation, grass is cut and the whole field is cleaned. Often the grass is burned in the field in order to clean the land for sowing; sowing is perceived as more exhausting if the grass is left in the field (Crop calendar, Ilakala, 25.03.2014). Nevertheless, some farmers recognized the advantages, in terms of soil moisture and fertility, of not burning and rather ‘digging in’ grass residuals (Crop calendar, Ilakala, 25.03.2014, Crop calendar, Changarawe, 07.04.2014, Problem tree crop men, Iloilo, 18.02.2014). In Dodoma, the grass is sometimes also collected as fodder for the animals. If a new plot has to be prepared, often trees have to be removed and so the work is rather done only by men, because the work demands more physical effort (Crop calendar, Ilakala, 25.03.2014; Crop calendar, Changarawe, 07.04.2014).

Due to financial limitations, land preparation in most cases is mainly done using a hand hoe. According to the participants, this limits cultivation to small portions of land and hence, reduces the output.

Woman:

“If you use a hand hoe you will always get a low yield because you can only plant few crops.”(Problem tree crop, Ilakala, 21.03.2014)

4.3 Agricultural activities and collective problem assessment

Only few farmers are able to afford either oxen (in Dodoma) or tractors (in Morogoro), which would assist with soil preparation. In Morogoro, oxen are not popular for tilling. Not only accessibility but also availability of farming tools is limited. Even if people are able to pay for the service, it does not necessarily mean that they will also benefit from the service. If equipment for preparation has to be rented this creates an additional problem: One is dependent upon others. For ox hoes in Ilolo it was mentioned:

Man:

“Most people don’t have an ox hoe, so they have to wait in the long chain. But then the rain comes and when you reach the ox hoe the rain is already cut off. That’s a problem.” (Problem tree crop, Ilolo, 18.02.2014)

Because tractors in both Morogoro CSS come from outside the village, sometimes even from Dodoma, farmers reported a similar problem concerning the availability of tractors:

“There is no tractor in the village but we can get a tractor from the neighboring villages like Ulaya or Kilombero. The tractors only come in certain seasons, e.g. if you want a tractor now you won’t get one. They are owned by rich people and they have their times when they bring them here but they also have the time when they need them themselves.” (Seasonal calendar, Ilakala, 25.03.2014)

“Tractors are very scarce. Sometimes you pay money but in the end they don’t come or come way too late.” (Feedback seminar, Ilakala, 16.04.2014)

Man (about tractors):

“You must wait for others to finish. It’s not that everyone will get it at the right time.” (Livelihood analysis 2, Changarawe, 02.04.2014)

Another issue affecting land preparation is the conflict between livestock keepers and crop farmers in Morogoro. This is a big point of concern for the village people. In both CSS, farmers were constantly complaining about livestock keepers that herd their cattle and small ruminants on other peoples’ farms after harvest. The major problem here is that the soil is getting very hard from compaction:

Man:

“The cattle is passing on the field during the dry season and after the harvest. Now the problem is that they make the land very hard. They cause a drought of the land. So without using a tractor for tilling, the land will stay hard and if you cultivate next season you won’t get anything.” (Problem tree crop, Ilakala, 21.03.2014)

Person:

“If the livestock keepers let their cattle on the field together with the sun the soil gets very hard and the maize doesn’t grow well. It just happened on my field last week. The Masai promised to refund the loss but nothing was paid up to now and not even 100 000Tsh would cover the loss.” (Crop calendar, Changarawe, 07.04.2014)

It was mentioned that especially people having farms close to the livestock keeper's sub village "Camp" in Ilakala suffer from that situation. As described in Changarawe, in few cases the cattle are even entering before harvest, which can be a disaster for the whole harvest. Tension in the conflict is high, but there are yet no useful regulations to solve it. Villagers are asked to note the exact coding of each cattle that passed on their ground for refunding the loss but for example, in Changarawe one farmer reported:

"Even if you blame a person that his cattle were in your field, he will ask you 'which mark did the cattle have?'. But how should I know which kind of marks when I am not even a livestock keeper." (Problem tree crop men, Changarawe, 04.04.2014)

4.3.2.2 Seeding

Depending on the rainfall, people start sowing with the first rain. Seeding and tilling are done almost simultaneously. However, since the probability of rainfall in semi-arid Dodoma is even lower than in Morogoro, some farmers seed before the first rain so *"that the seeds will be already in the soil when the rain arrives"* (Crop calendar, Iloilo, 23.01.2014). Especially in Ilakala and Changarawe, participants reported that the local extension officer introduced them to keeping certain distances between planting holes and rows for the optimal development of the plants. Some farmers use long ropes with marks to plant seeds in straight rows.

Intercropping is very common due to local limitations of space, time and manpower. If certain crops do not have negative effects on each other and they fit in timing, people consider it as beneficial to plant them together on one field because two harvests can be obtained in the same area. Common examples are a combination of groundnut and millet, cotton and pigeon pea, maize and pumpkin, or sesame and bambara nuts.

The majority of the participants reported to use local seeds, which are stored by the farmers for the next season. Participants were frequently complaining that only local seeds are available or accessible to them. Quality attributes identified as important in all CSS to them were: Early maturation (especially in Dodoma CSS), high produce and drought resistance.

Man:

"Because of the temperature in Dodoma rainfall will usually only last for 2 months. That's why we have decided to use fast maturing varieties that can manage the conditions. Rainfall is a problem to all crops. When rainfall ends the crops otherwise might not be matured." (Problem tree crop, Idifu, 31.01.2014)

Local seeds do not satisfy these demands. For example in Dodoma, it was expressed that local seeds take long to mature, which makes growing them more risky in times of increasing drought risk. In Iloilo as well as in Idifu, there is a local seed trader in the village. Many villagers in those villages are encouraged to use the fast maturing seeds. Especially the so called "messia" sorghum seed is famous. What is hindering them is the necessity to buy them again every year. For example the local trader in Idifu was reported to take around 7000Tsh/kg for modern seeds, depending on the type of seed,

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in 2014. This is not complying with how the system used to function, namely building a seed storage for the next year, which used to make farmers independent from external seed suppliers. In other CSS there was no trader but farmers trade seeds among each other. In Morogoro, seeds usually get introduced by those who can afford the costs to go to town and buy seeds there. Seeds in Kilosa were named to cost around 5000Tsh/kg in 2014. In the next season, they sell to their neighbors for a lower price than if those neighbors would need to go to town to buy seeds. This year, the price in the village was around 3000Tsh/kg.

Man:

“Even if you don’t have money to buy modern seeds maybe the neighbor went to Kilosa and bought seeds and in the next season you just go to the neighbor to buy his seeds.” (Problem tree crop, Ilakala, 20.03.2014)

A source for quality seeds in Morogoro was reported to be the ARI station Ilonga. Even if new seeds were introduced to the village, participants recognized that their output became less favorable over time which creates the need to buy new seeds frequently instead of traditional storage and local exchange systems. They reported that they sometimes could only afford a small portion of quality seeds because seeds are sold per kg, so they mixed them with local seeds on the field. New varieties were especially demanded for the major food and cash crops: millet, maize and sesame. Participants justified the selection in the following terms:

Man:

“Especially Maize because if it would get a higher yield the problem of food shortage would be solved. Especially sesame, because this would mean that we would get enough income.” (Problem tree crop, Ilakala, 21.03.2014)

Man:

“Sometimes you can find maize giving out two cobs or in terms of drought resistance it is surviving better and it is early maturing. The owner will get out of hunger faster because he can harvest earlier.” (Problem tree crop, Changarawe, 04.04.2014)

To illustrate farmers decision making on seed selection, an example of sesame from Ilakala shall be summarized (Seasonal calendar, Ilakala, 19.03.014): There are two types of seeds available Sihada and Lindi2. Some farmers like Lindi2 because it is drought resistant, it has big seeds and when it dries and it is time for harvesting, all the leaves wither and leave only sesame seeds without leaves so it is easy to harvest because you easily recognize when the crop is ready to be harvested. Sihada is drought resistant as well but takes longer to mature and the leaves do not wither. Even though, about half of the farmers of that discussion preferred Sihada because overall it has more seeds and grows well. (Seasonal calendar, Ilakala, 19.03.014)

When trying out new seeds, farmers try to avoid risk by first only farming a small portion of land with the new seeds, or by waiting for the neighbor’s results.

“We buy new seeds once they are on the market, but we will maintain our old seeds on a portion of land. We had some new seeds which did not do well, but now there

are good seeds which we buy and separate when planting, the new ones from the old ones, to see which ones have better yields.” (Seasonal calendar, Ilakala, 19.03.2014)

Thereby, it can be compared which seeds generate higher yields and are more beneficial.

4.3.2.3 Weeding

Weeding is for all crops usually taking place two times. Almost all participants reported that weeding is a very exhausting and time consuming activity exclusively done by hand hoe in all CSS. Exhaustion was especially expressed by women, who reported that the period of weeding also brings the danger of injuries due to using a hand hoe. While for field preparation oxen or tractor could be used to prepare larger areas, there is no alternative to the hand hoe for weeding.

“Weeding activities are difficult because there is no equipment for weeding. We are digging with the ox hoe but for weeding we have to use the hand hoe. Maybe you prepare 10 acre with an ox hoe but during weeding it’s difficult to weed this area.” (Livelihood 2 men, Idifu, 11.02.2014)

If people were able to till their land by oxen or tractor, they reported that at least the amount of weeds was less than when exclusively using a hand hoe. Otherwise, whenever the rain starts, people are almost overwhelmed by weeds.

Man:

“When there is no rain, you cannot weed. But when the rain comes the weeds are so many and you get nothing.” (Problem tree crop, Ilolo, 18.02.2014)

Effects of too many weeds were described as: Yellow leaves in maize (Problem tree crop men, Changarawe, 04.04.2014), yellow millet and weeds destroying the sorghum (Problem tree crop, Ilolo, 18.02.2014) and weeds suppressing the rice to grow (Crop calendar, Idifu, 10.02.2014). Interestingly, rather the technique of weeding was mentioned as major problem related to weeding than single persistent weeds as such.

Weeds are especially a problem for rice cultivation. In Morogoro CSS, some rice farmers reported to use herbicides against weeds in rice. Otherwise, fields have to be weeded by hand whilst standing in water all day long. Participants in Idifu reported that some weeds grow much faster than the rice and overwhelm it easily.

“There is the problem that sometimes there are more weeds than rice plants and the weeds suppress the rice. But we cannot use hoes in the wetland. We need to use hands for weeding.” (Problem tree crop men, Idifu, 31.01.2014)

Weeding also depends a lot on timing. If people do not manage to weed the complete field in time, or to weed at all, the crops will be overwhelmed by weeds.

Man:

“There is this weed and if you are late to do weeding it will destroy the sorghum. The sorghum will get yellow.” (Problem tree crop, Ilolo, 18.02.2014)

According to the participants, this can be due to the aforementioned reasons that fields are often too big to be weeded by two people by hand hoe, or that people are engaged in casual labor in order to gain money and food.

To narrow the time demand of weeding in Changarawe, an innovative farmer recognized the value of intercropping with pumpkins:

“I am mixing with pumpkin but do not cut the big pumpkin leaves. Thus, I only have to weed once because the leaves prevent the weeds to come out fast.”

(Crop calendar, Changarawe, 07.04.2014)

4.3.2.4 Crop maturation and the environment

Drought

As mentioned earlier, climate is one of the limiting factors determining farming activities. In all villages, participants reported that throughout recent years the weather has become increasingly unpredictable. There occurred several years of drought in a row.

In Ilakala and Changarawe people relate the lack of water and rainfall to increasing deforestation (Feedback seminars, Ilakala 15.04.2014 and Changarawe, 17.04.2014). Elders in Idifu and Ilolo understood the changing environment as a result of the Ujamaa “villagization” program, dismantling tradition and environmental degradation and population increase.

“It started around 1971 from the time we were brought together to start Ujamaa. I think it is a curse because this communism brought the destruction of farms with food like sorghum when they cleared the place for the Ujamaa settlement.

In former years things were good because we had freedom in our traditions and it rained a lot. When rains failed, we sacrificed during the dry season and rains returned. Today people do not believe in traditions like those.” (Interview, Idifu, 14.02.2014)

Man:

“If you ask our elders here, during their youth, the rain was enough and the reason is in that time there was still forest and no environmental destruction. So there was enough rain and there was no pest. And there were few farmers. Now there are many farmers. For example, I am farming in my grandfather’s farm and we are 60 grandchildren. That means, the farm that was cultivated by one person is now cultivated by sixty people.”(Problem tree crop, men, Ilolo, 18.02.2014)

Looking at the seasonal calendars of the season 2012/2013, drought, high temperatures and strong sun were reported with spatial variation. People referred to two major effects of this: Firstly, it directly affects the crops, making them dry and leading to low or no output at all. One of the most important staples in Morogoro--

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maize-- is especially affected by drought situations, as one of the most important cash crops in Dodoma --groundnut. According to the participants, only few crops were able to develop at least an average output, among them bullrush millet in Ilolo and Idifu, bambara nuts in Idifu and maize and sesame in Changarawe (Seasonal calendars, tables 19, 20, 21, 22). If rain is lacking after seeding, the seeds are not germinating, which is demanding for reseeding; hence, generating additional financial demand on the HH.

It was furthermore, observed that drought effects differ for different soil types that have different water holding capacity. In Idifu, women recognized that the sun easily dries the sandy soils while red soils still stay wet (Net map women, Idifu, 30.01.2014). In Morogoro CSS, farmers as well appreciated farms at bottom areas because of water availability for plants. In Changarawe, farmers expressed that, in former years those people farming at the bottom were often affected by floods and standing water, but for the past five years owners of plots in the bottom areas are advantaged (Net map, men, Changarawe, 03.04.2014).

Secondly, another major effect of recurrent drought is that farmers become insecure in scheduling their farming activities. They report that for their fore parents, the weather was much more predictable and all farmers had a more or less fixed farming schedule, but nowadays farmers have to adapt to the situation but don't know how.

Man:

"Before, in ten years drought only occurred once or twice, but now there was a drought five years in a row." (Problem tree crop, Ilakala, 21.03.2014)

It became more obvious during a crop calendar session in Changarawe, where participants disagreed with each other and had different reasons, all related to rainfall, to plant either in December or in February (Crop calendar, Changarawe, 07.04.2014) Also for cotton in Ilakala participants mentioned:

"For those years with good rainfall you could see people planting cotton from February up to the 15th of March, but nowadays because of the rain the days are not the same for planting. People are planting just randomly." (Crop calendar, Ilakala, 25.03.2014)

It is creating a situation in which 'traditional' knowledge is not offering solutions to the challenges of these times. As a women in Idifu expressed: *"If the rainfall is missing even the clever ones will get problems."* (Net map, women, Idifu, 30.01.2014) Some crops cannot at all be grown efficiently anymore:

Man:

"Others are not growing groundnut anymore. Groundnuts are a good cash crop in the area, but because of the scarcity of rainfall in the last year, people did not get anything so they did not have seeds to grow groundnut this year." (Net map, Ilolo, 19.02.2014)

Woman:

"I used to cultivate rice. Now it was the third year in a row that I did not get a harvest. I get nothing at all. It is due to the sun being so hot. Now I have given up but I would still like to cultivate rice." (Livelihood 1, Ilakala, 15.03.2014)

Due to the hard soil, certain strategies do not work efficiently anymore neither, e.g. the application of animal manure or the use of oxen in Dodoma:

Woman:

"With little rainfall even oxen cannot be used anymore because the soil is too hard." (Problem tree crop, Idifu, 31.01.2014)

Coping strategies are limited. In Dodoma CSS, farmers already use more drought resistant millet varieties for years. Additionally, people started to plant before rainfall, so that the seeds will be already in the soil when rain arrives (Problem tree crop men, Ilolo 18.02.2014 & Idifu, 31.01.2014) and people believe in the help of fast maturing varieties, but are hindered in purchasing them. Intercropping is also helping to at least get some yield from an acre of land: Millet is intercropped with groundnuts and, although last year groundnuts did not generate yield at all, millet could be harvested (Problem tree crop women, Idifu, 31.01.2014)

In all CSS and in many discussions, irrigation was a pertinent topic and was perceived to be potentially assisting during times of drought. But as a farmer in Changarawe realized: *"The river is far away from the maize field"* (Feedback seminar, Changarawe, 17.04.2014). Although most crops are rainfed, the vegetable fields are additionally irrigated during maturation of the crops. In the Dodoma wet lands especially, irrigation is done by hand using buckets. People often dig their own wells near the field, from where they transport the water to the respective area. In Morogoro, people benefit from the proximity to rivers. In Changarawe, more vegetables are grown than in Ilakala. People are able to afford or to rent pumps for irrigation. Nobody is only a vegetable farmer because rainfall is the restricting factor. Efficient irrigation schemes and water storage facilities were demanded by many participants to help them overcome the problem of water scarcity on the fields. They generate this information from experiences in other regions like one farmer in Idifu:

Man:

"In other regions I have travelled to, like Morogoro, I saw that most of the people irrigate their farms, they can have big dams for water and every sub village can irrigate by using a machine." (Problem tree crop, Idifu, 31.01.2014)

During a feedback session in Ilolo, one participant was raising the idea to capture water during the rainy season. Because if it rains there is so much water around, and they should somehow collect it around the farms to make use of it (Feedback seminar, Ilolo, 19.04.2014).

Soil cultivation

People in all CSS complained about low soil fertility, which is thought to affect their output and the limited means to overcome this situation. Many reported that fertility is strongly related to preparing land only by hand hoe, because *the fertile part of the soil would stay down* (Problem tree crop, women, Ilakala, 21.03.2014).

In Morogoro, farmers are not familiar with the application of animal manure to increase soil fertility. There is no cooperation between livestock keepers in the villages and farmers. As a more or less mixed farming system in the Dodoma region, the application of manure is common. Nevertheless, since not all farmers keep livestock, some of them have to buy the manure. For participating farmers in Dodoma, it was also an issue how to transport the manure to the field and to apply it. Additionally, participants recognized that there is a negative relation between manure application and a drought situation:

Man (2013 year of drought):

“Usually with manure you harvest more. But last year those who put manure even harvested less.” (Problem tree, Ilolo, 18.02.2014)

Some innovative farmers already found other ways in order to increase soil fertility and in Ilolo a method was introduced to farmers by an agricultural organization:

“The time I grow papaya, I make a tunnel and put the maize residuals inside and put soil on top. When you grow any crop on that tunnel it will grow up healthy.” (Problem tree crop men, Ilolo, 18.02.2014)

In Ilakala, farmers recognized the value of digging in grass residuals after land preparation or applying organic household wastes in the home garden.

“You just throw the leftovers from food on the area around the homestead and if you cultivate there the crops become very good.” (Problem tree crop men, Ilakala, 21.03.2014)

Particularly in Ilakala and Changarawe, participants mentioned the effects of farming on slopes. While the bottom parts are very fertile, the slopes are less fertile and not all crops can be planted there. Problems occurred here due to erosion. In Ilakala, farmers reported that they tried to work with terraces but it did not help and made the problem even worse. This made obvious that the technique is probably not a traditional one and its proper introduction failed.

Man:

“When it rains the fertile part is taken down. We tried to terrace but the soil part was taken away and it even got worse. We tried to leave space between the terraces to let the water pass, but sometimes the space was not enough.” (Problem tree crop, Ilakala, 21.03.2014)

Pests and Diseases

Unpredictable pests and diseases create big output losses. These occur on different levels during the development of the crops. During the seasonal calendar sessions pests and diseases were always mentioned as the major constraint. Different pest and diseases are out of the list of constraints almost the only ones specific to different crops (compare annex 2).

Most often, the only solution perceived by participants in all CSS was to hope that the rain would come to wash away insects. Only in sesame production in Morogoro CSS, pesticides were always applied, because participants reported that otherwise almost nothing could be harvested. The dependency on pesticides when growing sesame can be seen as a problem in itself, in the least because it increases the capital requirements of the household to buy pesticides and to rent the applicator. It was explicitly pointed out in Morogoro that the major staples maize and rice is not as strongly affected by pests and diseases as sesame for example and therefore, also does not demand pesticide application. Other crops with regular pesticide application are pigeon pea and cotton.

The problem with pesticides is not only about its accessibility but also about the application as such. Some farmers report about insecurity when applying the pesticides concerning proper handling and application.

“There are certain lice special for pigeon pea. They are disturbing farmers. We are applying pesticides but we are not sure about the pesticides we are using. That is a very big problem. Sometimes we present our problems to the vendor but the ones who are selling are not professionals. So the person might just give you the wrong pesticide because they are in need of money and are not so much concerned if the pesticide really works.” (Seasonal calendar crop, Ilakala, 25.03.2014)

Furthermore, not many people can afford their own applicator. Therefore, people borrow or rent to each other but this can delay the application.

“If for example 119 people are planting cotton but only 4 solar applicators are coming for pesticide application you will have to rotate. But by that time the pests will already finish the cotton.” (Seasonal calendar crop, Ilakala, 25.03.2014)

However, in sesame, and also with other plants, participants reported on a rather new pest infestation during flowering in February, for which pesticides do not work efficiently:

“At the beginning, these insects of flowering were not there but after a long drought these insects started to invade the fields and they cause big losses. Now it is coming every year. The insects which come in January die early when we spray with pesticides but the insects which come in February do not respond to pesticides. Only when the rains come, they die out.” (Crop calendar, Ilakala, 19.03.2014)

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In other cases, if insects overwhelm the fields early in the season, there is still the option to replant, but as mentioned, especially in Dodoma there is also the risk *“that the rainfall might have gone away”* (Problem tree crop women, Idifu, 31.01.2014). In Dodoma, none of the participants was able to buy pesticides.

In Annex 2, a collection of pests and diseases (as described and perceived as pests and or disease by the participants) is given. The description includes direct citation from participants. It obviates that not all pests and diseases are well known to the participants and that farmers' definition of diseases is rather broad, including 'real' diseases as well as, for example, effects of nutrient deficiency. For instance, for yellowing leaves in maize, it was reported that they mainly occur if planted on sandy soils or on slopes. This could suggest that the crop has a nutrient deficiency rather than (what science would define as) a plant disease.

Pests and diseases basically occur on all major crops grown. Some pests and diseases were reported to spread between different crops. Participants in Ilakala explained that insects affecting cassava may go over to sesame. Therefore, the insecticide used in sesame also works for cassava (Crop calendar, Ilakala, 19.03.2014). Pigeon pea for example was reported to benefit from intercropping with cotton and the according application of pesticides.

In addition to pest and diseases, birds attack the plants. Birds are a problem for farmers most especially during maturation of the grains or, in Dodoma, during the time when water is standing in the wetland areas after heavy rainfall. In Morogoro, due to the proximity to the forest and national park, monkeys also become a big problem during the time of maturation. Farmers commented that they especially like maize and you never know when they will come.

Man:

“Especially in maize from the day you start planting you will have to watch out. Sometimes people are just overwhelmed by the monkeys.” (Problem tree crop, Ilakala, 21.03.2014)

4.3.2.5 Harvest and storage

The harvest takes place by hand. Depending on the crop, people either pick by hand or use equipment such as bush knives. After drying on the field, the product is then transported home by feet or oxen cart in Dodoma, or by feet, bicycle or motorcycle in Morogoro. Bicycles and motorcycles are owned by men, meaning that the transport in this case is also done by men.

Grains are stored as food and seed for the upcoming season. According to participants, a lot of stored products are lost due to damage by pests and diseases. There were several reasons mentioned for this issue. It begins with the preparation of the harvest in the field. A farmer in Ilolo commented:

“The problem here is that we don’t let the crops dry well in the farm because every person has food shortage. If you leave the maize like this (on the field) when you come next month you find nothing left. And the other problem is, we live with livestock keepers. If you are late to harvest some people can feed their cattle in your farm. So people harvest basing on those forces and when you store it’s eaten by pests.” (Problem tree crop men, Ilolo, 18.02.2014)

Proper drying of the harvest is limited due to food shortage, the fear of thievery and livestock keepers grazing their cattle on the farm. But also insects already appear on the farm and harvest needs to be saved from those as well.

Later on, most people store the produce in polyethylene bags or plastic buckets, although they are unsatisfied at least with the bags because insects and rodents can enter into the bags and destroy the seeds. Some farmers for some crops also make use of chemical seed treatment. This was reported for pigeon pea in Ilakala where farmers separate between grain for food and grain for seeding.

“Every farmer has a certain mechanism to make sure that the seeds are not destroyed and they use a certain pesticide to prevent the problem.” (Seasonal calendar, Ilakala, 25.03.2014)

If seeds are destroyed they are still used for alimentation.

Woman:

“If you have poor storage facilities and insects have entered and destroyed the seeds you have to eat the seeds because they are not suitable for seeding anymore. So we just bring them to the milling machine to at least get flour out of it.” (Livelihood 2, Ilakala, 17.03.2014)

However, traditional storage containers are not very common anymore. In few cases crops are still stored in a traditional way using smoke to keep away insects, as is sometimes happening for Maize in Ilakala (Problem tree crop men, Ilakala, 20.03.2014).

4.3.2.6 Marketing

What could be obtained from farming under given limitations is first of all stored. But still, for every HH it is as well important to sell surplus in order to obtain income. Even poor people make a cash based opportunity cost decision about the use of seeds for food versus for selling.

None of the CSS has a reachable fixed market where products could be traded.

Man:

“What he means is, there is a market but very far, therefore transportation costs increase. So a person is forced to sell the groundnut in the village and the grapes are rotten in the farm because when he says he needs to transport it he (the trader)

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will incur more costs. So the market is very far from the producers.” (Problem tree crop, Iloilo, 18.02.2014)

Travelling to the next bigger market was not perceived to be economically feasible. Therefore in all villages, farmers feel forced to trade with small local traders that come from inside or outside of the village and look for certain products after harvest. In Idifu, there is a settled trader in the village who is buying and selling products year round and who also offers credit. He is only buying in bigger quantities. If HH want to obtain e.g. soap or salt from a shop there is furthermore, the option to exchange 1kg of grain against the needed product.

Woman:

“If I need some sugar today, I take one kilogram of my millet and I go to a small shop. I give them that millet and they will give me a half kg of sugar.” (Net map, Idifu, 30.01.2014)

In this situation, the villages are somehow separated from the free market situation and this provides a lot of space for traders to make use of their market power. After harvest, prices are low. In the villages, it was reported that traders agree among each other about even lower and fixed prices, which is comparable to oligopolistic behavior. Farmers feel forced to accept the prices because they are in need of money and food, since the storage from last season is by this time usually empty.

Man:

“To store crops for future use or to store crops in order to sell them later for farming activities is difficult because all food ended in the middle before reaching the next season.” (Problem tree crop, Iloilo, 18.02.2014)

Few people, the ‘rich’, are able to store for longer and wait until prices increase again. The few who are named to be ‘rich’ were also related to having better marketing channels.

Man:

“The ones with the food crops may sell to those with a lot of cash crops, but for a low price. The cash crop growers then have a good connection to outside traders.” (Net map, Iloilo, 19.02.2014)

Additionally, the information on the market situation outside of the village is very narrow and entrepreneurial behavior is simply not expressed by everyone and is usually not part of what people learned from their parents. This is understandable since post colonial agricultural marketing was highly regulated by the government.

“In former years it was the government that decided about the price. Since there is a free market, prices are not good. A person may come this day and can tell you any price according to where he is coming from.” (Feedback seminar, Iloilo, 19.04.2014)

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People do usually not inform themselves in advance about prices they could expect. They said that they only wait for the traders to tell them the prices (Feedback, Iloilo, Ilakala, 19.04.2014). This market information asymmetry renders people even more vulnerable to the behavior of local traders.

As pointed out by the farmer in Iloilo, farmers are often not satisfied with the prices they can achieve for their harvest. They recognize the seasonal and yearly price fluctuation and complained about their low bargaining power and fixed prices of local traders. People are increasingly insecure of which income they can expect from their harvest. Against common thinking that a drought would increase prices for the harvest in Iloilo, for instance, people reported that prices get even lower because fewer traders are coming to the village. Since traders know the harvest was bad and it might therefore not be lucrative to travel to the village, only a few bother and they have an even better position for determining the prices (Problem tree crop women, Iloilo, 18.02.2014).

The trading situation is slightly different for certain crops. For example, cotton in Ilakala is traded via the National Cotton Board. This involves a form of contract farming where people are supplied with inputs and equipment in advance, which will be later on subtracted from their payment. Although this is creating a certain amount of financial security, people were complaining that often after harvest they don't receive the money that was promised to them and that the Cotton Board is the single buyer of cotton in the region; hence, it has a monopolistic position (Crop calendar, Ilakala, 25.03.2014).

Also for sesame, there exist alternative trading schemes. People call it "money for leaves". Traders have recognized the high dependency on pesticides and that some farmers are not able to afford these pesticides. Therefore, they come to the village to offer the farmers money in advance to buy pesticides. Farmers have to sign a type of contract which is in most cases determining the price for which the farmer will have to sell after harvest to the respective trader. This price is most often much lower than the free market price. If farmers are not in need, they rather tend to avoid this way of trading (Crop calendar, Changarawe, 07.04.2014).

Cooperatives or group marketing is not common in all CSS. Only in Iloilo one farmer, member of the PMG group, reported about the benefits of his farmer's group in order to overcome the problem of market power and market accessibility:

"The leaders communicate with the buyer and he comes to buy at an agreed market. We may agree on a meeting point, like here in the village. Then it will be simple for the bulk buyer, he can come with his car and fill the bulk. Thereby we empower farmers because when they are many they can as well decide for the price. When they agree on a certain price, and the bulk buyer sees the bulk, it is easy to attract him and he will accept the price, rather than when he buys in small amount from each single one of the farmers." (Interview: farmer groups, Iloilo, 22.02.2014)

For cotton and sesame in Ilakala and Changarawe, people also complained about the measurement practices of the traders. They would rather prefer official measures

because they do not trust the measures of the traders. They feel as if the small traders are stealing from them (Crop calendar, Changarawe, 07.04.2014).

To sum up, major financial loss reasons as explained include the availability and accessibility of official markets, asymmetric market information and according market power for local traders, and volatile prices.

4.3.2.7 Summary

Table 23 is summarizing the results of this chapter. General problems are valid for all types of farmers in all CSS. If any specific problem was identified for a certain group during the discussion it is indicated in the table.

Table 23 is illustrating that for wealthier farmers problems rather occur due to the low availability of inputs or equipment that may dismantle their management plans and therefore lower output. The second order supply and processing sector is not well developed in any of the villages, although it is slightly better developed in Changarawe and Iloilo than in Ilakala and Idifu. Nevertheless, the rich have the option to otherwise cover tasks by increasing labor through hired labor.

On the other hand, the problems expressed by the poor are revealing that there is high demand for cost intensive inputs but since they are highly capital constrained they cannot afford them. This point is also revealing that poor so far developed few low-cost innovations and alternative strategies themselves to overcome their situations but are rather farming under stable conditions, which may be partly due to their strategy of risk aversion. The poor are the ones suffering most from connected problems along the whole chain leading finally to low output and low financial income in the face of low market power which is creating a vicious cycle for the next season.

Interestingly table 23 is revealing that participants did not mention any problems specific to men. In contrast, women suffer mainly from high workload and low involvement into commercial agriculture.

Differences between regions are few, although this table is not covering differences among sub villages. Those mostly make up rather a difference in depth and importance of problems and are mainly due to the position of single sub villages in the region and the according resource endowment and infrastructure. Nevertheless, the sessions in Morogoro revealed that in contrast to Dodoma farmers are more insecure in how to cope with the climate change situation. As for them the situation of insecure rainfall is rather new, they have not yet developed efficient strategies to cope with the problem, like introducing drought resistant crops such as sorghum and millet varieties in Dodoma. Most persistent in all discussions in Morogoro was the conflict between pastoralist and farmers although effects are at the moment probably rather of moral value in comparison to other problems.

Table 23 Summarized problems along the crop value chain

	Land preparation	Seeding	Weeding	Maturation			Harvest & Storage	Marketing
General		Use of local seeds	No alternative for hand hoe	Drought	Soil degradation	Pests and diseases	Pest and diseases, thievery, quality of storage facilities	Missing market place, low prices
Men	-	-	-	-	-	-	-	-
Women			Work load, injuries					Less involvement
Rich	Availability of oxen/tractor	Availability of quality seeds (high yielding, drought resistant)						
Poor	Accesability of oxen/tractor, only available tool:hand hoe, timing (wage labor vs. own farm)	Accesability of quality seeds (high yielding, drought resistant), timing (wage labor vs. own farm)	Retroactive effects of using hand hoe already for land preparation (weeds ↑), timing (wage labor vs. own farm)			Accesability of pesticides and equipment	Limited means for transport of harvest	Dependency on local traders, low bargaining power, urgent financial demand, "money for leaves"
Dodoma	Availability of oxen					Birds		
Morogoro	Availability of tractor, Soil compaction: social conflict between pastoralists and farmers			Slopes disadvantaged	No organic fertilizer application	Monkeys, Birds	Conflict with pastoralists	
Villages/Sub-villages	e.g. Camp, Ilakala							
Crop			Especially rice	Especially maize, groundnut, rice		Especially sesame, pigeon pea, cotton		

Drought and pest and diseases are those issues affecting specific crops according to the resistance of specific crops to those constraints. Major food and cash crops are affected by those issues, which leads to high losses for all farmers. The farmers are well aware of the existence of varieties that are resistant to those issues; nevertheless, their use remains low in all CSS due to low availability and accessibility of seeds.

4.3.3 Livestock production

The importance as livelihood activity and distribution of livestock among the CSS was already illustrated in point 4.1. Gendered livestock activities were highlighted in point 4.2, table 16. In this section, procedures of keeping the major livestock species are explained in more detail. Information was mainly obtained through the livestock calendar sessions in all villages.

Points of discussion included feeding and watering of the animals, their reproduction, health, the kinds of stables and marketing. During the sessions, it became obvious that only few activities follow seasonality, those are related to feeding. This is due to the fact that the availability of fodder is affected by the climate, hence follows seasonality. The development of a calendar to summarize activities in livestock keeping did, hence, only partly make sense for the participants. Main results of the sessions are summarized in table 24.

In general, it was expressed that all livestock is mainly kept for selling to generate income. Best selling time is after harvest, when people can invest money. Livestock keepers barely slaughter themselves. Only special occasions, such as funerals, give a reason to slaughter an animal. The man of the household would then be responsible for slaughtering.

Table 24 Livestock production

Livestock	Region	Output	Feeding	Watering	Stable	Reproduction	Further activities	Marketing
Cattle	Dodoma	Income, offspring, animal power, milk, manure, (meat)	Pasture January- June in the village, big herd: July-December outside the village, small herd: July -December residuals, stored grasses	Own wells near the wet land				Livestock market, local butcher
	Morogoro	Income, offspring, milk, (meat)	Pasture January- October in the village, big herd: July-October outside the village, small herd: July -October grazing on harvested fields	River or natural ponds	Fence-like stables/enclosures made of wood and branches: at night, (small herds: all dry season)	Autonomous: during pasture time	Milking: ca. 6- 12 months	Livestock market, local butcher, milk in 20l buckets
Goats and sheeps	Dodoma		Pasture January- June in the village, July -December residuals, stored grasses	Own wells near the wet land	Fence-like stables/enclosures made of wood and branches: at night,all dry season	Autonomous: during pasture time		Livestock market, local butcher
	Morogoro	Income, offspring, (Goat:milk)	Pasture January- October in the village, July -October grazing on harvested fields	River or natural ponds				Local traders, local butcher
Pigs	Dodoma	Income, offspring, manure	Maize bran, remains of brewing local alcohol, sunflower residuals, rice residuals, grasses during rainy season	Pure water or watery bran (maize bran enriched with water)	Shelters made of wood and branches: all year	Sign of heat of the sow: organization of a boar	Separation of piglets from sow: after ca. 2 months, Castration: after ca. 5 months	Inside the village
	Morogoro	Income, offspring	Maize bran, grasses during rainy season					
Poultry	Dodoma							Inside the village
	Morogoro	Income, nutrition, offspring	All year: autonomous, after harvest: maize bran, sorghum	Autonomous by animals during the day	Inside the house: at night, freely during the day	Autonomous		Inside the village, traders from Mikumi or Kilosa

(source: Seasonal calendar livestock)

Cattle

Cattle in Dodoma are kept for different purposes. The outputs used in Dodoma are: money, drought power, milk, meat, and manure. With the introduction of the HADO program in 1973, the numbers of cattle in the two Dodoma CSS was reduced. Since the 1990s cattle was reintroduced to the region and since 2003 the stocks have significantly increased again (URT, 2012). Cattle are interesting for people from Idifu and Ilolo because of its value in terms of animal power:

“For the HADO project the livestock was taken away. It was only allowed to keep dairy livestock. Now, people try to have oxen for cultivation and the number of livestock is increasing again since HADO. HADO decreased the economic status of the people. Our livestock was taken to other villages where many had relatives, but until they reached the new place, many animals died.” (Feedback seminar, Ilolo, 19.04.2014)

Oxen are a highly valued source of drought power, not only for the owner but also for other renting farmers. Nevertheless, its use is exclusive to those who can afford to purchase or rent.

In Morogoro, the few cattle keepers in Ilakala and Changarawe keep them to obtain milk, meat and money. Neither drought power nor manure is used in those CSS.

In both regions local breeds are kept. Participants could not give specific information about the breeds they keep.

All calves are kept to increase the herd, because the bigger the herd the richer the livestock keeper. The young calves are fed with milk. As long as the calves drink milk, the cow is milked. In Idifu, livestock keepers mentioned that this takes usually around six months but could last up to one year (Livestock calendar, Idifu, 12.02.2014). For milking, the cow gets stimulated by letting the calf suck, afterwards the cow gets milked and thereafter the remaining milk will be given to the calf. Older calves stay in the stable and get fed with grasses that the livestock keepers bring to them.

When cattle are old enough, they go to pasture in herds. Usually from January until June herding can take place in the vicinity of the Dodoma villages, in Morogoro sometimes even up to October. People in Dodoma either herd their cattle on common ground in the village and/or herd as well on own areas that they left aside to let grasses grow. In Morogoro, livestock keepers just go to any uncultivated area. In Dodoma, cattle can drink in own wells that the livestock keepers dig near the swamp. In Morogoro, cattle are drinking water from the river or natural ponds during herding. During these months, cattle are also mating freely without any organization on the pasture. Pasture time in Dodoma was reported to be from 7am to 1pm in the morning and again from 3pm to 6pm in the afternoon but with big cattle one may stay at the field all day (Livestock calendar, Idifu, 12.02.2012). In Morogoro, cattle keepers explained they stay out for pasture from 11am until 6pm (Livestock calendar, Ilakala, 24.03.2014). At night, cattle are brought back to the homestead and stay in enclosures made of wood and branches. No additional water is supplied at night. During rainy season, the fences may be extended because of wetness. The stables have to stay close to houses because of thievery.

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In Dodoma, herding is often organized by merging herds and rotation among livestock keepers. In Ilolo, one man was for example reporting about rotation with others every three days (Livestock calendar, Ilolo, 24.01.2014) but it depends on individual agreements. Herding as a form of wage labor is possible in Dodoma as well. Rotation becomes especially important during the dry season. During that time in Dodoma, big herds (more than 30 cattle; Livestock calendar, Idifu, 12.02.2014) are moved away because otherwise available fodder and water would not be enough. Herders may even pay rent for areas in other places to let the herds graze there. In comparison, smaller herds remain in the village and are fed with harvest residues, especially groundnut hay and stored grasses.

Cattle are sold on livestock markets or to the local butcher if there is need for money. The price is a question of bargaining and depends on the size. Cows can reach a price of one million Tsh (Livestock calendar, Idifu, 12.02.2014). Bulls are in general more expensive. Milk is only sold in Morogoro CSS in 20l buckets.

Goat

Goats are mainly kept to generate income. The local goat breed does not give sufficient milk to make milk attractive for trade and it was reported that the milk neither is tasty. Even though, there is demand for milk goats, but financial constraints hinder goat keepers:

Man:

“We would like to keep milk goats, because they are important. Someone with high capital can manage cows but those with low capital can have at least goats and sheep. If they would have milk goats they could obtain milk for their families, for their nutrition. So even if they don’t have a cow it would be easier to have nutritious food. But we don’t have money to buy the milk goats.” (Problem tree crop men, Idifu, 31.01.2014)

Only in Ilakala one man owns the so called “muzungu” goat that he kept for milking (Livestock calendar, Ilakala, 20.03.2014). He found this type of goat at a friend’s place in another village and bought one. He can milk the goat for 3 months.

During the rainy season, goats go to pasture. In Ilolo and Idifu, goats often get mixed together with cattle in bigger herds. Finding pasture sites for goats was reported to be easier than for others because they can also climb up trees and eat the small leaves. Mating is mainly taking place while they are at the pasture site. For the dry season, the goats are kept in their own stable made of wood and branches nearby the house. In Dodoma, households commonly stored groundnut hay as fodder during that time. In Ilakala, goat keepers explained that they do not store any fodder but rather take the goats to the fields that are already harvested to eat the leftovers from harvest.

Best time for selling is as well after harvest. In Dodoma, goats are traded on a livestock market. In Morogoro, there are goat traders that pass by the households. If one is urgently in need of money it is also possible to sell the goat to the local butcher. In Ilolo and Idifu prices of 60 000 to 70 000Tsh can be obtained after harvest, in a bad season

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it may be only 25 000 to 30 000Tsh (Livestock calendar, Idifu, 12.02.2014 and Iloilo, 24.01.2014). In Ilakala, a female goat goes for 50 000 to 60 000Tsh and a male for 80 000Tsh.

Pig

Pigs are in all CSS a rather new species in comparison to ruminants and chicken. In Idifu, older participants explained:

“When we were young we didn’t know and didn’t see pigs, just the wild pigs. We started in 1987 but only with few people. We introduced pigs to the village. One man went to another district and came back with a pig. He learned from the people there how to take care of that pig.” (Livestock calendar, Idifu, 13.02.2014)

And in Iloilo participants expressed that during the last ten years the number of people keeping pigs *“increased like hundred times”* (Livestock calendar, Iloilo, 21.02.2014). In Morogoro CSS, the number of pig keepers is low because there are more Muslims in the village that do not eat pig meat.

Pigs are exclusively kept to obtain money. In Dodoma also surplus manure is sold and used for vegetable production. Prices for pig manure are higher than for cattle manure. Pigs are kept in shelters made of wood and branches.



Figure 14 Pig stable, Iloilo (source: Photo, M. Höhne)

In Dodoma CSS, it was observed by the researcher that some pigs also run around freely or go to find grasses during the rainy season. Nevertheless, pig keepers claimed

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to only keep their pigs inside the stables because otherwise they destroy the crops. Some pig keepers may let them free in the dry season and after harvest.

The sow gets separated from the piglets after ca. 2 months. The young male piglets get castrated after ca. 5 months. Most piglets are sold because otherwise feeding costs get too high, as livestock keepers in Iloilo explained (Livestock calendar, Iloilo, 21.2.2014). Sows get mated if the livestock keeper recognizes the sign of heat. If the person does not own an own boar, sows are brought to a neighbor who owns a boar. As payment it is common in Dodoma as well as in Morogoro, to give the boar owner one of the new piglets.

During the dry season, in all CSS pigs are fed with maize bran in the morning and evening. Additionally, farmers in Dodoma mentioned to feed them the remains of brewing local alcohol, sunflower residues or rice residues in Idifu (Livestock calendar, Idifu, 13.02.2014). Rice residues were reported to be less preferred because they are not as good for fattening the pig as e.g. maize bran. Maize bran in Dodoma needs to be bought from the milling machines.

Since Maize is farmed more commonly in Morogoro, farmers explained that they obtain maize bran right when milling their own maize. During the rainy season, pig keepers mix the rations with grass and feed grasses especially in the evening. Grasses are collected on the way from the farm back home. Pigs are supplied with water either in the form of watery bran or as water as such, but pig owners mentioned that pigs drink around 5l per day (Livestock calendar, Idifu, 13.02.2014 and Iloilo, 21.02.2014).

To completely grow out a pig it may take up to two years but often they are already sold after the first six to eight months. Pigs get usually sold to a local butcher. Prices are bargained and depend on the size of the pig. Very big pigs can obtain prices up to 300 000Tsh in Dododoma. In Ilakala pig keepers mentioned to get 15 000 to 80 000Tsh for a pig of eight months. The best prices in Iloilo get long fat breeds. Therefore, they are preferred by pig keepers. Additionally, also short breeds and long thin breeds can be found in the village (Livestock calendar, Iloilo, 21.02.2014). In Ilakala, the few pig keepers have all the same breed: a black and white and short one.

Poultry

Most important poultry kept in all CSS are local chicken. Additionally, ducks are kept as well as guinea fowls, so called "Kanga" in Dodoma CSS. In all CSS, a strong desire for broilers was expressed due to the big size they can reach. Local chicken are kept to obtain meat and income. They serve as a financial insurance even for low income households.

"My situation is one of poverty so there are the chicken that assist me." (Problem tree livestock, Changarawe, 05.04.2014)

Chicken are not kept to sell their eggs. Few eggs might be used for home consumption but the majority shall hatch. This is also due to the low number of eggs laid as well as the small price you can obtain with selling eggs in comparison to selling a whole

chicken. Chicken can occasionally also serve as a source of meat for household nutrition when other types of meat are too expensive:

Man:

“For instance you need some meat. Then you go to the butcher and you find that it is 5000 Tsh per kilogram, and that 1kg is not enough for the whole family. Then I realized that keeping chicken can help. Instead of going to the butcher to buy 1kg of cow meat, I slaughter a chicken.” (Livelihood analysis 1, Ilakala, 15.03.2014)

Poultry is kept at night most often inside the houses together with the family. This is due to costs involved in building a proper stable but mainly due to the fear of losses from theft and carnivores at night. In the morning, they leave the house to search for food and come back in the evening. After harvest, maize bran or sorghum might be fed additionally, but only if available.

“During the dry season after harvesting we give millet, but later it is difficult because we give the millet that we eat as well.” (Livestock calendar, Idifu, 13.02.2014)

Chicken are sold inside the village whenever the household is in need of money. Demand inside the villages is sufficient. In Morogoro CSS, it was additionally reported that traders from Mikumi or Kilosa regularly pass around to buy chicken. The range of price is high from 3000Tsh up to 15 000Tsh for a big cock.

Few people keep ducks because the market for ducks is small in all CSS. Those who keep them like them because they have more meat than chicken.

The guinea fowl or “Kanga” are only domesticated in Dodoma CSS. In Ilakala, farmers expressed interest in keeping “Kanga”. However, in the nearby forest those birds still live in the wild. Guinea fowls in Dodoma are highly appreciated because of the high rate of reproduction, disease resistance and high prices (Problem tree livestock, Ilolo, 24.01.2014). Eggs are sold as well. Participants in Ilolo explained that “Kanga” do not properly incubate the own eggs so often chicken are used for incubation (Problem tree livestock, Ilolo, 24.01.2014).

4.3.4 The livestock keeper’s problems in livestock production

With the help of the sessions on livestock production, major areas of livestock keepers’ concern could be identified. Those include the feeding, the housing and livestock’s health and marketing. Concrete problems in these areas depend on the specific way in which livestock is kept and are often interrelated. One can say that problems in livestock keeping are related to common areas of concern along the value chain but, in difference to crop farming, they are highly specific to the respective species and conditions in the region. Livestock keepers expressed and explained their problems and interrelations in livestock keeping mainly through the development of a problem tree.

4.3.4.1 Feeding

All animals kept are fed with herbal fodder. Three ways of feeding can be identified: Herding, the collection of grasses and herbs and the feeding of crop residues. Since the plant development depends on climatic conditions also the feed stock was affected by the aforementioned droughts of the last years. This had different implications for the three ways of feeding. Problems due to food shortage are in general more severe for bigger animals (ruminants and pigs) than for poultry.

Herding

In all CSS, participants complained that the area they are allowed to use as pasture for their ruminants in vicinity of the villages is becoming smaller and smaller. During the last years, the availability of pasture was additionally decreased as effect of the droughts. In both Dodoma CSS, furthermore, the sources of water are limited for bigger animals. The livestock keepers are forced to bring their herds increasingly far away.

“Water was a problem last year. We walked up to two miles to the main water source.” (Livestock calendar, Ilolo, 24.01.2014)

Not only distance to herding places but also the times of herding nearby and far from the villages are changing. In Ilakala, livestock keepers expressed that there is increasing competition with herders from other areas. For Ilakala, livestock keepers reported that:

“The pasture was not sufficient. There was competition for pasture because there were also other cattle from other villages like Kiduhi. We even lost some livestock because of the lack of pasture.” (Livestock calendar, Ilakala, 24.03.2014)

The livestock keepers started to move much earlier to other places to feed the cattle than usually.

“We started to move to other villages in August and we came back in December and January this year.” (Livestock calendar, Ilakala, 24.03.2014)

Collection of grass and crop residues

Small herds, small ruminants and pigs remain in the villages during the dry season. Hence, they get fed with crop residues from the rainy season. In Dodoma CSS, people reported to keep fodder storage with dried grasses and crop leaves but additionally herd the ruminants in the remaining areas. Ruminant keepers in Ilakala do not keep such storage but rather herd the animals on harvested areas. For small ruminants in general it was reported that sheep suffer more from hunger than goats because goats are able to climb up the trees and catch the remaining leaves. Nevertheless, for goats it was expressed that they are picky and only like groundnut and maize hay as dry matter. If you could not harvest those crops in the past season it is a problem (Livestock calendar, Idifu, 12.02.2014).

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“During the dry season we have to provide the goat with the maize and ground nut leaves, while cows eat everything that you store.” (Livestock calendar, Idifu, 12.02.2014)

The droughts of the last years in Dodoma CSS were severe. Livestock keepers reported that the goats even started to eat plastic bags, which is a threat to their health.

Keeping pigs in years of drought is a problem as well, because they eat a lot. During the rainy season, they are fed with grasses that people can collect for free. But the shorter the rainy season, the less grasses and the earlier people have to start to buy fodder which is increasing the capital demand for pig owners. In times of drought and low production, in general this can furthermore create a trade-off between using money to feed the family and using money to feed and maintain a high-value animal.

“That is the major problem. You may find that pigs don’t have food, yourself you don’t have food and your own kids neither.” (Livestock calendar, Ilolo, 21.02.2014)

They feed pigs with maize bran. The maize residues are a product people received for free in early years but which nowadays needs to be purchased from the milling machines because of the increasing number of pig keepers in Dodoma.

“It gets hard because in the past we were very few pig keepers so fodder availability was easy. But now we are too many and we buy bran, something we were given for free.” (Livestock calendar, Ilolo, 21.02.2014)

In Dodoma CSS where maize production is low, maize residues need to be ordered in advance. Last year, it was especially hard to get them and people travelled up to Dodoma town to obtain affordable maize bran.

*“Where did you buy bran last year?
- At Dodoma town.
And how much time did you spend to town?
- By bicycle it is 8 hrs.”
(Livestock calendar, Ilolo, 21.02.2014)*

Those who could not afford to travel switched to other sources of fodder:

“Last year was a bad year so also the residues were not good. We used millet, maize or sunflower residues for the fattening of the pig but last year we had to use rice residues which are not good. Rice residues don’t bring vitamins to pigs and they are not fattening the pig. But last year we could really just feed the rice residues and the price was very high, about 12 000 Tsh/bag.” (Livestock calendar, Idifu, 13.02.2014)

As feeding of pigs is a risk in terms of capital demand, different to cattle, piglets are not all kept to increase the herd.

Effects of droughts

During the last years of drought, livestock keepers experienced big losses, especially of those bigger animals that remained in the villages. This was more pronounced in Dodoma than in Morogoro. For keepers of small herds it is especially a problem because with every animal dying a financial asset is lost that was supposed to make up for potential losses in crop farming.

Many of the remaining animals were weakened and livestock keepers recognized that thus, reproduction gets less and they are more susceptible to diseases. Some examples shall be given here:

- *“Why did the cows not get pregnant although you brought bulls to them?*
- *Because they lacked food! Those cows that moved to different places and got pasture and grew faster they also got mated. But in case of mine that only stay in one place, they don’t get enough food.”* (Livestock calendar, Idifu, 12.02.2014)

“If the mother goat is not fed properly there is not enough milk for the kids and they don’t drink enough. The pastures were not enough so the young goats were very weak, some goats died but due to diseases, because the diseases arise with shortage of pasture.” (Livestock calendar, Ilakala, 20.03.2014)

“In the last year few pigs were born because of hunger. Some pigs also died because of hunger, especially the small ones.” (Livestock calendar, Idifu, 13.02.2014)

“Sometimes the pigs already give birth after 4 months to premature babies and the babies just die. It does not happen very often and it may be due to poor feeding.” (Problem tree livestock, Ilakala, 21.03.2014)

Another effect is one of marketing. Animals are traded due to size. Skinny animals hence, will not obtain a high price. So even if your animal survived it will be hard to sell it for a reasonable price.

“Last season there was a shortage of rainfall and the feeds were not enough. That is why they buy the goats only for fifty thousand, although, normally they buy them for sixty thousand Tsh.” (Livestock calendar, Ilolo, 24.01.2014)

4.3.4.2 Health

Diseases and parasites are an all year occurring phenomenon for livestock keepers but as mentioned in the previous section, effects may be increased with the weak physical condition of animals due to fodder shortage.

Parasites

Different parasites occur on different animals.

For ruminants it was said they are mainly attacked by ticks and the tse-tse fly. The parasites are especially many during the rainy season. The problem here is not only

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that they weaken the body of the animals and may transfer diseases but also that they go over to humans and transfer as well diseases.

Dipping to prevent parasites is for most livestock keepers very costly. In Dodoma, participants reported that before HADO, regular livestock dipping was organized by the government in Mvumi (Problem tree crop men, Idifu, 31.01.2014). Now, they do it whenever it is affordable to them and diseases have increased a lot (Problem tree crop men, Idifu, 31.01.2014). Livestock keepers from Ilakala explained that they use the preventing spray more often.

“During the dry season, we spray once per week but during the rainy season when flies and other parasites increase, we do it twice per day in the morning and evening every day. The frequent treatment of the cattle reduces the diseases but sometimes we don't have money to buy the drugs and we fail to treat frequently. Then the diseases increase.” (Livestock calendar, Ilakala, 20.03.2014)

Poultry is getting lice and mite. Those parasites distract hens during the incubation of eggs and thereby, erode reproduction of the chicken.

Woman:

“Mites are born when the chicken incubates. So where it is incubating, you will find some very tiny insect on the chicken. So those mites suck the blood of the chicken. And the chicken gets tired and loses a lot of blood. Then she fails to incubate the eggs and finally decides to leave the nest.” (Problem tree livestock, Ilakala, 22.03.2014)

Because human and poultry stay in the same house at night those parasites are also persistent problems for the poultry keepers. The problem of poultry housing will be explained more in detail in the next section.

One of the major problems related to pigs were mentioned to be worms that lead to diarrhea. The main goal for pig keepers is to get a fat pig; hence, diarrhea is undermining this effort and is weakening the body of the pig. Pig keepers were mentioning two reasons for the persistent occurrence of worms in pigs. First, pigs eat everything and because pigs are a rather new species in the area pig keepers are not well aware of which would be the perfect diet for them.

Woman:

“We keep pigs but we don't know the real pig's food.” (Problem tree livestock, Idifu, 07.02.2014)

Second, pig stables are not safe and pigs escape many times, so they can feed on anything coming on their free way. The problem of the 'right' construction of stables shall be picked up in the following section. De-worming medicine was reported to be available and effective in all CSS, what was hindering people to apply it are costs involved, also because worms occur so often and just come back fast after treatment.

“We have one challenge, you can buy a medicine and come to treat your pigs, but at the end the drug does not do what it intended to do. Also due to the nature of our house, the worms always increase because the pigs always keep digging in their house.” (Livestock calendar, Iloilo, 21.02.2014)

Diseases

Diseases are specific to the type of livestock. Major diseases mentioned are summarized in table 25.

Table 25 is indicating that especially ruminants and chicken are suffering from diseases.

For ruminants, over all CSS, the strongest problem was reported to be a lung disease, affecting all types of ruminants (compare table 25). Different ruminants infect each other when they are herded together. The effects are stronger for goat and sheep than for cattle. The participants expressed that it is hard to cure this disease as it develops very fast and the animals die within few days. Also it is a rather new disease for the livestock keepers. It spread very fast among their herds in the last year and they yet, did not find the right strategy of how to handle the problem.

Chicken are affected by a range of diseases, among them the most important ones in all CSS are the New castle disease/ “Sotoka” and eye and eye lid infections (compare table 25). Especially New castle could be prevented by vaccination. After outbreak of the disease, there is no healing medicine available. Nevertheless, the issue with chicken is that they are comparatively cheap (Livestock calendar, Idifu, 13.02.2014). Hence, sometimes it is cheaper and easier to let them die, eat them and buy a new one rather than make the effort of organizing the vaccination. However, in Changarawe chicken keepers and the extension officer became active and organized themselves in a group to organize medicine for vaccination:

“We can afford the preventive medicine because we organize ourselves in a group and all contribute money. We are assisted by the ‘bwana shamba’. He buys in a bulk and we buy from him. We do that for many years already.” (Problem tree livestock, Changarawe, 05.04.2014)

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Table 25 Livestock diseases as mentioned and described by participants

Livestock	Disease or Symptom	Description	Source of description	
Ruminants	Lung disease	The cow started with a flew and the front legs started to walk slowly, saliver, after dying the lungs were looking big, in 2013 the problem prolonged from June/ July up to December. After recognising the symptoms it only takes 3-4 days until the animals die. Symptoms are the same for cattle and goat. The animals had lungs problems and enlargement of the gallbladder. When you slaughter them you find that the lungs are squeezed together in one side. There arose a disease which was never there before. It is a lungs problem called "mapaf". The lungs are swollen and press against the ribs.	Problem tree livestock, men, Idifu, 01.02.2014 Livestock calender, Idifu, 12.02.2014 Livestock calender, llakala, 20.03.2014	
	Foot rot	From January to June, the cattle gets foot problems because of the nature of our stable.	Livestock calender, Idifu, 12.02.2014	
	Constipation	The stomach is full but no faeces come out. The animals look weak, don't eat and don't drink and finally they die. People don't know the causes but some of animals have swollen lungs as well. It happens when they start to eat fresh leaves, after rain when they stayed hungry for a long time.	Problem tree livestock, men, Idifu, 01.02.2014	
	Kidney	After the animal died people cut it and saw the big kidney being swollen. When they cut the kidney water is coming out, sometimes blood. Before dying, the hair of the animal is staying up. Generally occurs for cattle but sometimes as well for goats.	Problem tree livestock, men, Idifu, 01.02.2014	
	Mental problem (Goat)	Goats run very far away and you have to follow them for a long time. People don't know what the problem is. If one goat got the disease they treat them traditionally but then after a short period of time the next one has it. In the group of 30 goats 4 of them might have the disease but not at the same time. Traditional treatment: you take goat back home and you cut a part of the ear and it is done.	Livestock calender, llakala, 20.03.2014	
Poultry	Newcastle disease	Chicken always get Newcastle disease. Newcastle disease kills a lot. Ducks get a disease like dizziness, fall down and then die. "Sotoka", diarrhea, There is prevention and the antidote is given every three months. "Sotoka" disease. The chicken gets sleepy and after a while it dies. People don't know where it comes from and what is the reason of the disease. Another symptoms is diarrhea. Sotoka is a transmission disease, on one chicken after another. It occurs from July until December. When the rain is enough the disease	Problem tree livestock, women, Idifu, 07.02.2014 Problem tree livestock, men, llolo, 20.02.2014 Problem tree livestock, women, llakala, 22.03.2014 Problem tree livestock, men, llakala, 21.03.2014	
	Swollen eyes	The eye starts to give out something like water and then it swells and covers the eye. When you try to open the eye, the stiff white water thing comes out of the eye. And they are very slippery. Sometimes the water thing can move also to the mouth. Swelling of the eyes and pimples around the head What is swollen is the eye lid, if you touch it sometimes something whitish comes out, the chicken becomes blind and dies. Every year it is a problem.	Problem tree livestock, women, llakala, 22.03.2014 Problem tree livestock, men, llakala, 21.03.2014 Problem tree livestock, men, llakala, 21.03.2014	
	Organs	I found the kidney and lungs to be swollen and the liver as well. The liver was covered with wounds.	Problem tree livestock, women, llakala, 22.03.2014	
	Legs	The legs disease is the disease in which the chicken fail to balance their legs. And when you slaughter one you find a slippery fluid on the knee. It's unusual to find such kind of fluid on the knee.	Problem tree livestock, women, llakala, 22.03.2014	
	Flew	The chicken just get a flew and die. It can occur any time. We don't is use medicine. Sometimes you just slaughter the chicken, but the taste is not good. In the lungs nothing can be seen.	Problem tree livestock, men, llakala, 21.03.2014	
	Pigs	Diarrhea	Diarrhea: sometimes when you just give pigs the maize bran or any kind of food, they become weak from diarrhea	Problem tree livestock, men, llakala, 21.03.2014

Medication

Regarding parasites and diseases in general, many problems are related to insecurity in the proper identification of diseases and the use and application of pharmaceuticals. If there is an outbreak of disease, the only one person to consult is the extension officer but there is no proper veterinarian available. Now, many people also experiment

4.3 Agricultural activities and collective problem assessment

themselves with pharmaceuticals and are sometimes disappointed with the results, which in the end lowers their belief in available medicine. People expressed for example:

Man:

“Without any kind of knowledge I try to give medicine and to treat the animal. When you go to buy medicine, the person who sells tries to give some information on how to apply medicine, but in the end some animals stay alive and some die.” (Problem tree livestock, Idifu, 01.02.2014)

“We need education about the proper medicine for pigs, like de-worming medicines because sometimes we buy fake medicine. But if you are educated you will know by yourselves that this is against worms or for the skin or anything else. If we are educated, no one can cheat on us easily.” (Livestock calendar, Ilolo, 21.02.2014)

Furthermore, there are no shops that sell livestock pharmaceuticals in the villages. People have to travel to the next bigger economic center where often one shop is responsible to supply the whole region.

Man:

“Mvumi is the center, so many people from many villages go there, but there is only one shop so sometimes you can go there and they neither have the medicine.” (Problem tree livestock, Ilolo, 20.02.2014)

Similar to all products that need to be purchased additionally, capital availability was named as a major constraint to get access to the right pharmaceuticals at the right time. Traditional medication and practices as an alternative of costly pharmaceuticals for livestock is still known to some people. Its application varies among livestock keepers. Some practices include:

Man:

“For eyes problems there is a certain tree. When you cut it you take the fluid and put it into the eyes. Then it is getting better.” (Problem tree livestock, Ilolo, 20.02.2014)

Man.

“If you see your cow is not eating you take a large amount of water. You boil it very well and pour it on its body and from that on the cow starts eating.” (Problem tree livestock, Ilolo, 20.02.2014)

“They take the muharobaini leaves the ones which are very mature, yellow in color. Then you grind them and mix together with the maize meal and then you give it to the chicks and if there is a disease it will never come again to that house.” (Problem tree livestock, Changarawe, 05.04.2014)

In contrast, some cattle keepers in Ilakala were arguing against traditional medicine, naming it outdated and not able and sure enough to cope with the modern diseases that livestock keepers nowadays have to face (Livestock calendar, Ilakala, 24.03.2014).

4.3.4.3 Stables

Ruminants and pigs are kept in stable like constructions made of wood. Livestock keepers in Dodoma complained that it is difficult to transport the wood from the forest up to the houses.

“Stable preparation is difficult. We take trees from far away. It took me three days in that mountain looking for poles to construct my cow stable and we don’t even have proper transport and other working tools like an axe.” (Livestock calendar, Idifu, 12.02.2014)

Furthermore, they are limited in resources and cannot afford an, according to them, more proper stable. Pig keepers would wish for a fixed stable made of bricks or wood and especially with concrete floor so that the pigs cannot escape anymore and destroy other peoples’ crops. As well, their feeding could be controlled, to prevent the constant occurrence of worms (Livestock calendar, Ilolo, 21.02.2014).

For ruminants, the major problem occurs in the rainy season when the fences are full of mud and manure. This leads to exhaustion of the cattle; they cannot sleep properly and some get foot rot. Furthermore, the fence construction is not always keeping wild animals from entering and killing the livestock. The major predator is hyena in Dodoma as well as in Ilakala.

“Sometimes the wild animals break into the fences and take our livestock. The common animal, which comes to take livestock here, is hyena which eats small animals like goat and sheep. In the previous years, lion was also a problem because of the proximity of the Mikumi National Park.” (Livestock calendar, Ilakala, 24.03.2014)

To protect poultry from carnivores and thieves they are kept inside the house. People suspect each other especially of stealing each other’s chicken. Catching a thief is hard.

Woman:

“There are two types of thieves, one is waiting until the chicken are inside and they break the door and they take the chicken. The other type is the one that is stealing from others. When chicken are outside and someone saw it and he felt like eating a chicken, he can use all of his effort to capture it. To discover him is not easy because you don’t have evidence. Sometimes chicken can lay eggs in the bushes, and sometimes in your neighbor’s chicken house. So they can be easily taken by someone. And those wild animals are in the bushes. So when the chicken goes around the human settlement, it is easily stolen.” (Problem tree livestock, Ilakala, 22.03.2014)

“Prevention of the stealing of chicken is not easy because they come and demolish the chicken house because it is never strong enough, even young boys come and break in and steal. There is nothing we can do about it.” (Problem tree livestock, Changarawe, 05.04.2014)

People prefer to let their chicken run around freely instead of building stables, also because of feeding issues. After harvest they may add millet in Dodoma or maize in Morogoro for their chicken but later when food is getting more and more limited, there develops a trade-off between feeding the chicken and having enough food for the HH.

“After harvesting, we give millet but later it is difficult because we give the millet that we also eat ourselves.” (Livestock calendar, Idifu, 13.02.2014)

In this case, it is much easier to let the poultry search for food by itself. Animal losses in this sense are then rather a very inconvenient side effect.

4.3.4.4 Marketing

For livestock that is traded within the village, the problems related to marketing and prices are very similar to those in crop production, namely: Asymmetric market information and market power of local traders that leads to low prices. In Ilakala one lady for example recognized that in Mikumi they sell chicken for 14000Tsh, the same chicken that people bought from them in the villages for 7000 or 8000Tsh (Problem tree livestock, Ilakala, 22.03.2014). However, since livestock like poultry, goats and pigs are much more traded among each other, oligopolistic behavior of single traders is smaller. Prices are bargained and depend mainly on seasonal liquidity. High prices can be obtained right after harvest and depend on the size of an animal.

Keeping pigs was reported to be rather risky because the market is not constant and, in contrast to chicken for example, you may not sell an animal at any time, first, because the price may absolutely not be reasonable in comparison to your investment and second, because there simply might be no buyer. However, in Ilolo participants recognized that the market for grown out pigs is developing while the one for the piglets is ever more decreasing.

“Sometimes they totally miss a market and we are forced to give the piglets to someone and the person can pay later and they will pay you buy installments.” (Livestock calendar, Ilolo, 21.02.2014)

The market for cattle is as well very seasonal. Seasonal markets limit the opportunity to get ad hoc money in moments of need. For example for the purchase of medicine in Ilakala it was mentioned:

“We have a seasonal cattle market and we have to wait for the marketing season and sell the cattle to get money to buy the medicines.” (Livestock calendar, Ilakala, 24.03.2014)

As the quote before is already indicating, due to the drought not all livestock keepers were able to wait for the seasonal markets or the higher prices after harvest because they were either not able to buy the fodder anymore:

*“When did you sell your livestock?
- When we had to add fodder and the feeds became expensive.”*
(Livestock calendar, Ilolo, 24.01.2014)

Or people were urgently in need of money. That was probably the biggest problem for the last years because situations of emergency increased and people felt much more forced to sell their high value livestock, even at any given price.

“Anybody can come and ask for the goats, and if I am in need of the money I will just sell for any price. But if someone comes with a very low price you really get stressed, sometimes you would even like to chase away that person because the price is not reasonable.” (Livestock calendar, Ilakala, 20.03.2014)

4.3.4.5 Summary

Livestock keeping is a separate livelihood activity, restricted to those farmers who can afford and maintain livestock. Reported problems were the same for all livestock keepers, therefore the differentiation in a table according to different types of farmers as done in part 4.2 and 4.3.2 does not make sense at this point. Nevertheless, what could be perceived was a difference in depth of problems according to the individual capital stock of the livestock keeper. Richer farmers keep high value livestock and have fewer problems to maintain their animals also during times of drought. Other differences are less livestock keeper specific but rather refer to the specific type of animal kept and are the same in all CSS.

Regional variation is mainly due to differences in fodder availability leading to higher fodder costs in Dodoma and longer distances to cover for herders during years of drought. Furthermore, the acceptance of livestock keepers differs in the regions. While in Dodoma, livestock keepers are well integrated into the society and farming practices, in Morogoro, pastoralists form a marginal group in society.

Differences in how livestock keepers approach different problems related to their animals are strongest when looking at the value of the respective animals. If problems in poultry occur, they can be easily covered with the purchase of new animals and problems make a difference only if many animals die. For high value livestock, each animal counts due to the costs involved. They were especially strong affected by the drought situation of the last years either due to a lack of feed or due to increased susceptibility to diseases. Losses led to significantly less financial output for the livestock owner.

5 Discussion

5. 1 Discussion of methods

5.1.1 The actor oriented approach

The methodological aim of this research was to roll out a participative situation analysis that involves the collection of site specific information, which is relevant to the actors of

the respective farming system and that assists in structuring, narrowing and describing the problem in focus of the overall research project. Participative group discussions formed the core element of methodology and basically followed two objectives. On the one hand, they were reaching a wide number of people and thus, could introduce the project and raise awareness, trust and acceptance among people of the CSS. On the other hand, they were following the specific objectives of this research and actively involved the actors of the system in focus in a cooperative manner (L.M. Webber, R. L. Ison, 1994), to “hand over the pen” (R. Chambers, 1994, p. 1254, b) and give them a voice and choice as they shall ultimately benefit of the project. A situation analysis is standing in the very beginning of a research process and many issues of local concern can at that point simply not be known by the researcher. To learn more about things of which existence one did not know, an open research design was applied that was supposed to be led by participants who decided about, evaluated and selected the information that they considered to be important.

A main principle of PRA is self-critical awareness of researchers concerning own attitudes and the personal responsibility on the flexibility of the process (R. Chambers, 1994, b). As for example already Schönhuth (1998) and Krummacher (2002) pointed out, participative approaches are very ambitious and put high demand on the researcher and the researchers attitude. For optimal preparation, the researcher of this study intensively studied various cases of PRA approaches and followed one week training in the frame of the seminar “Local knowledge” (B. Kaufman et al., 2013, University of Kassel). In the field, selected tools were tried and adapted during the first two weeks together with experienced supervisors. However, this was only offering a first guideline. Two weeks were a very short time to optimally adjust each tool to local circumstances. Optimal adjustment is not only limited by time, but also by the fact that PRA is not taking place in a lab where methods can be tested until perfection is reached. It is rolled out in a real-life situation and hence, will always demand for compromises (A. Cornwall, G. Pratt, 2003). There are various people involved with time-constraints and personal objectives. Long term testing in one place may additionally raise expectations and may potentially neither reach the desired goal as people are different and hence, every session is different. The researcher needed to be highly flexible and was most often rather following Chamber’s principle of “*use your own best judgment at any time*” (R. Chambers, 1994, p. 959). In this sense, being a rather inexperienced researcher was bone and bane at once. On the one hand, one can argue that the unbiased researcher was more able to engage with the local situation without prejudice due to former experience. On the other hand, this practical experience potentially could have helped in solving critical situations.

To get a second opinion, working with a translator was of big help. The translator’s job went far beyond pure translation. Because translators were Tanzanians, they were familiar with local habits and how to approach topics best. They informed the researcher about further interesting topics that would not have been obvious otherwise. Furthermore, they were assisting in cross-checking and discussion of topics in the field.

To reduce biased information, a large number of participants in a large number of sessions was consulted. Thereby, topics were repeated in various tools and different

views could be revealed. Further cross-checking of information was done during interviews and feedback seminars. Thereby, information gaps could be filled. Feedback seminars were as well a good opportunity to report back to participants and counteract the claim of Cornwall and Flemming (1989) that often PRA results are not shared and discussed with local people.

The number of participants, sessions and the accordingly rather long time in the field helped a lot to become known inside the CSS, to spread the idea of what was done, to raise interest and trust among people in the villages. Accordingly, in most CSS participation was very good and often more people wanted to join the discussions than possible. Participation was nevertheless, interrupted by the time frame chosen for investigation: The rainy season. During the rainy season farmers are less available because of farm activities. Chambers recognized that former studies often generated biased information because researchers preferred to visit areas during climatically convenient times (R. Chambers, 1994, a). However, here, the time frame was not chosen because of personal preference but due to project planning.

For some poor farmers the rainy season is the time of vanishing food and financial resources. Therefore, for some the financial remuneration offered by the researcher was the major incentive to participate and thus, honest contribution of some participants was rather limited. Nevertheless, investigation during the rainy season also had advantages as farming activities were still going on, which allowed the researcher to observe activities and realize some practices and problems on the field. Furthermore, as it was a good rainy season the production potential without impact of drought could be observed.

5.1.2 Selection of participants and group dynamics

The researcher was advised to invite participants through a local contact person because, as a stranger, you cannot just knock on somebody's door and ignore local structures and habits. Already Richards (1995) and Schönhuth (1998) pointed out that PRA is not taking place independent of local decision making structures and politics and hence, there is a need to recognize local forms of leadership and social relations.

However, the intention of the contact person was not always clear to the researcher. As the researcher beforehand did not know about local settings and power relations, in three out of four cases the local extension officer as governmental employee was selected as contact. The researcher perceived that often, the extension officer only transferred information to sub village heads who selected participants. Although the researcher was opting for selection by non-leaders, this could obviously not be achieved in all cases. Therefore one critically needed to evaluate, which people were selected and if they might have been under influence or pressure of the leaders to follow their objectives. In Idifu, work with the local contact person worked very well as she worked as translator and informant at the same time and a lot of time was spent together. Thereby, the purpose and what was actually done became clearer to her than to any of the other contact persons.

Even though participants could not be directly selected by the researcher, the criteria given by the researcher including difference in age, gender, socio-economic

background and non-participation in questionnaires were in most cases followed. In all sub villages sessions could be organized. Those points were helping to include different people of the society and to seek for diversity. There are always differences among farmers and PRA shall be used with sensitivity towards these issues of difference (A. Cornwall, 2003). Despite of obvious differences of age, gender and socio-economic background Krummacher (2004) claims that often social difference goes beyond common criteria and he rightly questions, if PRA is able to do justice to this diversity.

During the workshops, various reasons could lead to biased information that is inherently related to the dynamics of group discussions. Some of the reasons were already revealed by literature in part 2.3, among them unrevealed power relations among participants (A. Krummacher, 2004) and biased expectations of participants (A. Krummacher, 2004; A. Cornwall, S. Flemming, 1995).

Related to the selection criteria for participants, the researcher tried to understand if they would influence discussion due to obvious power relations such as the “male, old, rich man” as dominant speaker of a patriarchic society. This was not the case. Whenever somebody was dominating the discussions, those were mainly strong characters and could be of different age, socio-economic background and gender. It was hence, very unpredictable. However, the inclusion of various actors into a group discussion will never make this event informal, authority free and rational (A. Krummacher, 2004). To overcome dominance during all sessions, participants were addressed individually and respectfully. The moderator always tried to remember all names to create a personal atmosphere. Shy people were encouraged to speak. Nevertheless, strong differences were recognized between mixed and gender differentiated groups. In mixed discussions, many women stayed rather quiet. In general it was perceived that women needed more time to feel comfortable with the situation and to speak in front of a group. A lot of sensitivity and encouragement was demanded from the moderator and translator when working with women. This point is supported by Cornwall (2003), who demands to actively build especially women’s’ capacity to speak. According to her recommendations, the researcher tried to find appropriate space and time and was working only with female translators to create a comfortable ambient for participants (A. Cornwall, 2003).

The second point, that can lead to biased information are biased expectations of participants on the project (A. Krummacher, 2004; A. Cornwall, S. Flemming, 1995). At the beginning of each workshop, the aim and scope was always explained carefully. Nevertheless, in few workshops the translator could observe that people were hindering each other from telling certain aspects, for example having certain resources or doing certain off-farm activities, because they were afraid that this would keep them from receiving a certain benefit. Whenever this behavior could be observed, it was tried to sensitively make clear that this would not be the case. The researcher could also recognize that especially the problem tree tool was raising further expectations in the way that: ‘if a white person is coming from abroad to analyze our problems then this person must be an expert and will also give us solutions now.’ This is probably a very natural reaction in the face of different realities and it took some effort to explain that quick straight-away solutions are impossible at that point. It is partly due to the fact that

work realities, structures and planning differ between researchers and farmers and so do differ expectations on possible outcomes. The more researchers are coming to the field and the more effort is taken to discuss issues, the bigger can probably be the farmers' expectations that something 'big' will happen. Those people who had experience with development projects were therefore already very disenchanted. In Iloilo, where several projects already took place, this could be observed regularly. People expressed, they were tired of participation because usually the result of their efforts are small and rarely long lasting. It will be in the responsibility of the whole project to re-strengthen peoples' faith into participation in external projects and to generate strong long-term results that justify time and effort invested.

5.1.3 Selection of communication tools and visualization

Tools were selected beforehand and tested in the field. With more anthropological background information about the CSS, the tools could have been selected more adequately.

In all cases, introducing and explaining the tools, was done carefully but therefore also took a lot of time. But, during group discussion time is a critical factor. On the one hand, the researcher would like to cover all important points and understand relations. On the other hand, people are time-constrained, especially during the rainy season when a lot of field work needs to be done in time. Cornwall and Pratt (2010) summarized that some researchers claim that thus, PRA sessions take a lot of valuable time from people and disrupt peoples' lives. Therefore, the researcher always needs to reflect critically what the outcome of his activity is for the people and not to take participants time for something that does not always make sense to them. The time that could be used for discussion (around 1,5h to 2h) was highly limited by the concentration of participants and their personal willingness for participation. After a while, the majority of people got tired. Due to this point, tools should be as adequate as possible to be plausible for participants and hence, demand less time in explanation. Nevertheless, the researcher had the impression as if this is almost impossible. The demand for adequacy of tools is connected to the critique of Richards (1995) who raised the question: If using a certain tool that contains a predetermined structure like e.g. the structure of a calendar, is not already obliging a too closed structure on people? He is arguing that this structure, which is plausible to the researcher, does not necessarily need to be plausible to participants (P. Richards, 1995). For example a monthly calendar for all livestock activities was not plausible for participants. Activities for livestock were not following seasonality in terms of what is done in which month but were rather related to fodder availability. Although fodder availability follows a certain climatic seasonality, in recent years and due to effects of droughts activities could barely be identified following regularity. The discussion was adapted accordingly. Strongest adaptation was done for the net-map tool and the seasonal calendar tool for livestock. For both cases western pre-selected structures did not fit with local perception and structuring. The less plausible a tool was for participants the more the researcher needed to intervene, which often led to a strong guidance of the discussion by the researcher, which does not comply with the idea of letting participants guide the discussion (R. Chambers, 1994, b).

However, according to Percy (1999) visual techniques allow participants to express themselves even if they have low levels of literacy and by that to increase inclusion of all possible stakeholders. The level of education in the groups was very different. Here, Conroy (2001) recommends the use of symbols to include illiterate people. Nevertheless, those who could write always preferred to write which was excluding those who could not write. Finding common symbols did not work in many cases. The 'language' of symbols did not seem to be a common idea among people in the CSS. If individual contribution was demanded, e.g. for the problem trees, many participants decided for individual symbols such as dots or lines, which made sense to them but excluded others because their meaning was not visible to others. Painting pictures with the whole group was nice, but again took a lot of time, because often people were very shy in front of the group and in few cases somebody was straight away comfortable and willing to be the painter of the group. It was also perceived that people started to tease each other for "bad" paintings. Those constraints undermined the idea of a communication process between all actors of the group in order to find common understanding and to learn from each other (C.M. Webber, R.L. Ison, 1994). Although using tables seemed to be more plausible to participants, filling them with information did put another time constraint on the discussion. This was especially the case the more often the discussion needed to be interrupted because something was written down and others had to wait. Especially filling the tables, seemed to be something that people rather did to please the researcher than to structure own thoughts. The question back of "*and now, what shall we write*" occurred commonly.

Another critique is that visualization in a group discussion is leaving less space for individualism and is always opting for a group consensus, a point that was already criticized by Krummacher (2004). Furthermore, the public and formal character of group discussion will most likely only reveal general information (A. Krummacher, 2004) but a lot of information might be hidden in personal stories and backgrounds, which would take a lot of time to capture. This difficulty could be perceived especially when evaluating problems. The tools could only broadly reveal different problems for different types of farmers. During the problem tree tool, participants were at least asked to individually express, which problems are most important to them. As people differentiate among each other mainly through wealth classes, getting more information on identified problems and how they are aligned to different farmers could potentially be revealed more clearly with a questionnaire based on those wealth classes. Possibly, results of the first household survey of A. Faße et al. (2014) could already be of help.

Nevertheless, in the frame of this research visualization of topics during the discussion always helped the participants and the researcher to structure the discussion, to capture what was already said and what was still missing and to show interrelations. Thereby, the discussion could in all cases be 'made round' without randomly stumbling around and jumping between topics. This helped to use time more efficiently and increased the comparability of different findings in different places.

5.1.4 Translation and transcription

Neither participants, nor the translator nor the researcher is a native English speaker but qualitative data needed to be transferred into English for presentation. Van Nes et al. (2010) claim that differences of language between all parties of the research process may have consequences for its final outcome as concepts in one language may be understood differently in another one. This is especially important for qualitative research, as undertaken by this study, because it works with words and rich quotes are usually considered to contribute to its trustworthiness (F. van Nes et al., 2010). In general, *“qualitative research is considered valid when the distance between the meanings as experienced by the participants and the meanings as interpreted in the findings is as close as possible”* (Polkinghorne, 2007 in F. van Nes et al., 2010, p.314).

As mentioned before, the translators in the field were both very committed and tried to support the work as much as possible. Nevertheless, they were both not professional translators. Therefore there might be the difficulty that they did not translate all information vice versa to the researcher and participants correctly. Because during the field sessions only notes were taken by the researcher, the voice records were later on transcribed by translators other than the translators in the field to prove a second opinion. Because of constraints in finding suitable transcribers not all sessions could be again fully translated and transcribed. However, for each region and each session at least one fully translated and transcribed version is available for in depth analysis. Of the remaining records only the English part of the translator’s voice was transcribed or paraphrased by the researcher. This is incurring the danger of leaving out pieces of hidden information that were yet not translated by the translator or to overestimate pieces that were exaggerated by the translator. Therefore the fully translated transcripts of the second translator were used to cross-check findings and hence, to seek for trustworthiness and validity.

5.1.5 RRA versus PRA: a summary

The whole Trans-SEC project is inherently designed to take information from farmers and to give solutions based on this information from outside. This is shaping the researchers possibilities for action together with farmers. Furthermore, the way of participation, the complexity of some tools, the associated moderation and explanation demand and mainly the overall aim of this research formed this research to be more extractive. Even though, extractive does not exclude participative. People were continuously encouraged to name, structure and analyze their situation themselves. Hence, the methodological result is moving somewhere between PRA and RRA. This complies with Chambers (1994) assumption that many research approaches are rather a continuum between both (compare table 1). If standing alone, it can be rightly called RRA, because much information was analyzed and used by outsiders of the village. But in the frame of a longer project process it can be as well seen as the beginning of a longer PRA. Tenum and Due (2000) define the three essential stages of PRA as assessment, analysis and action. This study could hence, be positioned into the stage of “assessment” if the participative approach is continued and will increasingly encourage more action research and demand on villagers to involve themselves actively in the problem solving process. For the purpose of this study, the methodology

could fulfill its objectives. This study was not intending action. It was hence, rather helping to identify areas for action. Time constraints and the wideness of topics, that was not clear before start may have limited more detailed information on some relevant issues.

5. 2 Discussion of results

The aim of this research with regard to content was to understand current problems in agricultural production in four CSS in Tanzania in the light of the situational context, considering gender and other socio-cultural factors and thus, to identify potential constraints and opportunities for the design and uptake of innovations from the farmers' perspective. In the following, the site specific results of the three major topics of this study: Livelihood activities, agricultural resources and agricultural practices, shall be discussed to show interrelations among them and draw conclusions on the possible constraints and opportunities for the uptake of innovations.

5.2.1 Livelihood analysis

Workshops focusing on livelihood analysis and the net-maps revealed various activity profiles that helped to understand the importance of agriculture in the CSS and to identify different groups among the farmers in the CSS.

The results illustrate that many activities are the same in all CSS. Crop farming activities are in all CSS the major source of food and income for the majority of the population. Pure subsistence farming to generate only food could not be found in any of the CSS. Marketing of products and cash income is playing an increasingly big role for all farmers because a certain amount of cash is always needed to cover family expenses or even to process the own grain at the milling machine. Middle to low income groups are inherently dependent on agriculture. Some wealthier people can obtain a substantial amount of income from off-farm activities such as being a governmental employee or businessman. As the whole village business is somehow related to agriculture also those businessman undertake a business that serves agriculture e.g. as input supplier, trader or owner of a milling machine.

The overall low diversification of activities and the high dependency on crop farming in all CSS is a threat for sustainable livelihoods. "*A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both, now and in the future, while not undermining the natural resource base.*" (DFID in L. Kranz, 2001, p.3). Hence, the higher the reliance on a single activity, here crop farming, the higher the risk that this activity can be eroded from stress or shocks, here environmental and market volatilities. Already Morton (2007) is pointing out that livelihood diversification, including the integration of agricultural and non-agricultural livelihood strategies, is a positive resilience factor towards the challenges faced by agriculture nowadays. This is supported by the fact that those engaged as well in income generating off-farm activities in the CSS are among the wealthier inhabitants of the villages. As other high income opportunities in the villages are generally limited this increases the need for improvements in crop farming to enhance the systems resilience against future hazards and improve livelihood situations.

People differentiate among each other into poor and rich farmers. The situation is mainly determined by inheritance and options for the poor to economically rise are narrow in the villages. After several years of drought, even the middle income groups stagnate or drift into poverty because the outcome out of agriculture remained low for years. These are first indicators for considerable welfare losses on the African continent due to climate change, as emphasized by Komba and Muchapondwa. (2012). Improvements in infrastructure are counteracting the development because they offer new income opportunities. Also Ellis (1999) points out that infrastructural improvements may potentially impact rural poverty by contributing to the integration of national economies, improving the working of markets, speeding the flow of information, and increasing the mobility of people, resources and outputs and thereby, also offering new activity opportunities. For example the introduction of electricity to Changarawe assisted many livelihoods. In this light the plans of the Tanzanian government to equip more HH with electricity are highly welcomed.

Otherwise, the amount of off-farm activities in the CSS is limited by a limited and seasonal cash-circulation inside the village, especially the more remote an area is (compare Idifu), capital accumulation among very few people inside the village that dictate as well the local agricultural market and limited and seasonal demand for other services, although demand among the a bit wealthier farmers for agricultural inputs, processing entities and services is generally high.

Furthermore, there are personal attributes that allow a person to get engaged in one or the other off-farm activity and thus, potentially also rise in income. Results revealed that those attributes include: inheritance, gender, physical power and age, education, special agricultural education and skills, entrepreneurial behavior, the personal social network and contacts and the personal level of risk aversion and attitude towards uncertainty. According to those factors a strong, middle aged, well educated and well connected man with a positive attitude to try new things has a higher potential to economically rise, because those attributes can on the one hand, potentially impact his own farming practices and marketing habits and may on the other hand, offer him an opportunity to get involved into higher income generating off-farm activities. Ghadim and Pannell (1997) recognized that these are at least partly also the personal attributes beneficial for potential innovation adoption. They summarized factors specific to the individual farmer as the farmer's personal perception, his managerial skills and abilities, his risk preferences and attitudes towards uncertainty with higher risk aversion being rather unfavorable for innovations, as well as age and experience (A.K.A. Ghadim, D.J. Panell, 1997). They argue that higher age can be a positive attribute as skills are most likely advanced and there is more understanding for the system and its constraints (ibid.). Nevertheless, older farmers might have made experiences with other innovations and their perception is shaped accordingly (A.K.A. Ghadim, D.J. Pannell, 1997; D.J. Pannell, 1999). However, for the CSS very old farmers were rather risk averse as they suffered from physical constrains leading to capital limitations and food insecurity. Hence, A critical factor would rather be the physical capacity of people to try new things which would, in combination with Ghadim's and Pannell's (1997) demand for managerial skills and experience, point at middle aged farmers to be more likely to try a for them potentially beneficial innovation.

Looking more closely on gender, the analysis revealed that tasks for men and women differ due to the cultural perception of gender. Married women are involved into all major farming activities apart from trade and are additionally supposed to take care of the household and children. This is also the case for single female HH. In villages where there are not enough jobs available inside the village during the dry season, e.g. in Idifu, this is creating constraints for single female households because they cannot leave the village and so their additional income opportunities are even less. Same is the case for old farmers that are physically constrained to travel long distances. Hence, older farmers that do not get assistance from their children and single female households are more vulnerable to poverty.

In times of need, families generally have backup strategies. Those include especially the selling of livestock or if necessary the selling of household assets, such as valuable goods, land or parts of the food storage. Doing wage labor is the least profitable option. Wage labor is less preferred because of informal work conditions and low enforcement power of the employee to get his payment, very low payment for hard work and because of a management trade-off between using labor capacity and time to work on the own farm and meet the farming timetable or using labor capacity and time to satisfy family needs especially in terms of food supply. Also Tenge et al. (2004) point to possible interferences of off-farm activities and farming activities with negative effects for labor availability. So the opportunity to do wage labor is bone and bane at once for the rural poor. Following discussion with local people, one such paraphrased summary of a 'worst case scenario' example could look like this:

*'If there was a drought in the first year, you will get less produce, which won't be enough neither for food nor for income up to the next harvest, so you may start either selling or eating the grain that was stored as seeds for the next year. You won't have money left to buy new seeds so the first thing would be to do wage labor for others in order to organize food for the family at the same time organizing money to buy new seeds. So you might not be able to seed in time, might even miss the first rain, but those who are late might get problems. In the end the next harvest will again be less than expected and since you are urgently in need of money you will just sell to the next best small trader who is taking advantage of your situation and will buy for a low price.'*⁸

The lack of capital for development is thus, becoming a vicious circle for the poor. Nevertheless, wage labor has gained a fixed position in agricultural production. The poor need even this small amount of money to maintain their livelihoods and the wealthy would be less wealthy without their laborers (USAID, 2008), because otherwise they could not maintain the big farms and cover the work load because availability of assisting farming machinery that would limit the actual labor demand is low.

This section points out that the target group for innovation in agriculture should be the low to medium income farmers. The low income farmers suffer even in normal years from food insecurity and financial poverty and the middle income groups are potentially

⁸ Paraphrased from: Livelihood1, women , Ilakala (15.03.2014); Livelihood 2, women Ilakala (17.02.2014) & Changarawe 802.04.2014) & Idifu (06.02.2014) ; Problem tree crop, women, Ilakala (21.03.2014); Problem tree crop, men, Ilolo (18.02.2014) & Changarawe (04.04.2014)

vulnerable to drift into poverty in years of drought. Hence, innovations focusing on improving agriculture could improve the situation for the poor and limit the risk of poverty for the middle income groups, thereby helping to increase the system's resilience against future hazards and to sustain livelihoods. Furthermore, it seems to be helpful to support villages in developing an agricultural supplies market, meaning input and equipment supply as well as processing entities since this is the sector that is demanded and that could generate further employment opportunities while contributing to an enhancement of the circumstances for farming. Also Shiferaw et al. (2009) point out that often weak linkages to factor markets are a constraint to development in rural areas. To avoid oligopolistic or monopolistic behavior of single suppliers in this sector the introduction of cooperative management could be of help, e.g. the feasibility of an organization of a cooperative seed multiplication project to cover as well issues of quality seed availability and accessibility could be tested (FAO, 2010, Case study Côte d'Ivoire).

5.2.2 Resources and problems along the crop value chain

As off-farm activities are narrow, this points out the strong need to improve the major activity crop farming to, on the one hand, secure food supply and on the other hand generate enough surplus to generate an income and to sustain livelihoods.

As Panel (1999) emphasizes, the practical relevance of possible innovations needs to be obvious to the farmer and possible innovations should lead to a visibly better situation for the farmer than the starting situation in order to get adopted by the farmer in the long run. Hence, possible innovations need to respond to the farmer's problems in a holistic way. Therefore, in the following part, it shall be discussed which are the recent and strongest shortcomings in agriculture and on which levels improvement is needed. Those issues were revealed by detailed results of the seasonal crop calendars and problem trees.

The following part discusses problems mainly for the poor to middle income groups, which constitute the majority of the farmers in all CSS and for which problems were expressed to be strongest. Differences in problems on the village level are rather small and will therefore not be discussed in detail.

5.2.2.1 Resource limitations

Almost all farmers in the CSS work under low-external-input conditions, although not all of them suffer from resource poverty. There is a very small layer of wealthier people in all villages that is not resource poor per se but still farms under low-external-input conditions because the factor market and processing sector is not well developed in all CSS. Nevertheless, those people could generate a sufficient capital stock that allows them to have a "*decent and secure family livelihood*" (R. Chambers, B.P. Ghildyal, 1985). Thus, they are representing that there are options to develop even in the most remote village. Nevertheless, various interlinked factors restrict the majority from following this example.

In contrast, the poor suffer from resource poverty and "*their resources of land, water, labor and capital do not permit a decent and secure family livelihood*" (R. Chambers,

B.P. Ghildyal, 1985, p. 3). Even in average years, the poor often do not manage to cover the whole year with food and income out of farming. This makes them net-purchasers in the system. Here, market volatilities with price shocks can be a threat to poor smallholders by affecting household consumption in times when people need to spend money on food (IFAD, 2014). The middle income groups are somehow on the edge and strongly affected by the drought scenarios of recent years.

Because farming systems in the CSS are not subsistence systems but market dependent and because of a changing environment and a net-purchaser situation of many poor farmers the major limiting resource for development is thus, capital. Capital is the key to further resources such as land and labor or alternatively to change land and labor demand by influencing farming conditions through the use of external inputs and machinery. The reports of the farmers highlighted that farmers did yet not develop any further outstanding or wide-spread own innovations that would have allowed them to overcome resource constraints without capital. Capital was in all villages especially demanded for the rent of equipment that would assist with land preparation and weeding, as workloads here are especially high.

As other sources of income are negligible, the first to orientate and to aim for needs to be to stabilize and sustain the final monetary output of agriculture. This can be achieved through the combination of three innovation strategies: First, making better use of given resources and addressing some resource limitations; second, addressing current reasons for losses and third, getting more from the output in monetary terms. Those three strategies would either secure yields or in combination lead to an increase of yield and/or an increase of financial output for the farmer.

Capital

Coming back to the resource level and the first improvement strategy, important for any innovation adoption decision is the capital situation of the HH. The HH needs to be able and willing to invest some portion of its wealth to venture into an uncertain enterprise, which includes cost of establishing and maintaining the system (A.K.A. Ghadin, D.J. Pannell, 1997, D.J. Pannell, 1999).

For the development of innovations in the CSS the lack of capital has three implications. First, as the farmer needs to have the perception that innovations promote his objectives (D.J. Pannell, 1999), for innovation communication the objectives should principally involve and communicate the profitability of a technical change.

Second, the target group does not have starting capital and therefore, possible innovations cannot be capital demanding at all, meaning they cannot include the purchase of any expensive goods or services because personal discount rates of farmers are high. For the poor, future benefits are less significant than current survival and so current costs for trials may weigh more heavily than possible future benefits of such (D.J. Pannell, 1999). Furthermore, costs need to be evaluated not only in monetary terms but also in terms of opportunity costs of resource use and the incurred risk to venture into an uncertain enterprise (D.J. Pannell, 1999). If a trial includes the possibility of losses and may it be even a small one, this could keep poor from trying new things. Hence, innovation design needs to seek for solutions on how to buffer such

losses. An opportunity is to organize trials in groups so that the individual is not exposed to an economic risk he or she cannot buffer alone. Tenge et al. (2004) rate the membership of farmers in groups as beneficial for innovation trials. Groups may help to overcome resource constraints of an individual and may limit the risk of the individual by reducing individual investments and opportunity costs. However, the work in groups was not natural to participants and although throughout the last years various groups were introduced in the CSS, they are still a minor resource. Hence, strengthening and expanding existing structures would be in the interest of the project.

The third implication is that innovations should (additionally) focus on exactly this capital-limitation by introducing capital enhancing strategies that are sustainable on the long run. Credit availability, affecting liquidity, can be part of such arrangements (B.A. Shiferaw et al., 2009). But especially the long-run sustainability factor seems to be a big challenge. VICOBA in all villages already tried to introduce possible small scale micro credit schemes in the CSS but, as participants reported, they still seem to exclude the very poor HH. An important factor here, which also other researchers pointed to (F. Ellis, 1999; C.M. Moser, C.B. Barrett, 2003), is the seasonal liquidity of HH. Ad hoc money is mostly only available right after harvest. Pro-poor credit alternatives need to be found that are more flexible (as cash availability is seasonal) (B.A. Shiferaw, et al. 2009) and should probably at least in the first place rather include non-monetary deposits or interests (because they are usually not connected to seasonality). However, with given governance and infrastructure the introduction of such systems might be quite challenging.

Labor

Both, women and men are actively involved into crop production. Wagura Ndiritu et al. (2014) are demanding to pay attention to who is actually the manager of the farm in terms of gender, as this is not necessarily the same person as the household head, but may influence innovation adoption decisions. However, in the CSS it was reported that usually the men are the decision makers concerning farm management strategies, even if they may discuss issues with their wives. Hence, this informs with whom to interact for innovation introduction as the project is not taking place independently of local decision making structures and politics (P. Richards, 1995, M. Schönhuth, 1998). Even if innovations are meant to promote women's needs, they should not only be made plausible to the women themselves but especially also to their husbands as they might be the final decision makers.

Labor is a triggering resource for poor farmers. During farming times, the poor use their available family labor to its limits in order to produce crops. Thus, no additional labor can be set free during this time to support innovation trials, although other researchers claim that smallholder systems are labor abundant (C. M. Moser, C.B. Barrett, 2003). Hence, innovations cannot be labor intensive, as many low-cost low-external-input techniques are (A. Graves et al., 2004), and should focus in itself on reducing the workload and setting free labor for other activities. This is especially important for women as they usually take over most labor demanding activities during crop farming. This point is also appealing to Panel's (1999) argument that trials need to be feasible for the farmer and easy to be embedded into ongoing farming processes.

Innovations should therefore include an optimization of the farming schedules and management and/or a possible organization in groups to set free labor (A.J. Tenge et al., 2004). It is especially demanded for practices during labor peaks of land preparation and weeding.

This is also important in the light of the importance of wage labor for the poor during times of land preparation and weeding, which is often creating a trade-off for labor. The high dependency of the poor on wage labor, the interaction with farming activities and the resulting seasonal labor unavailability for further activities (rainy season, December to February) can be a critical factor for innovation identification (A.J. Tenge et al., 2004; C.M. Moser, C.B. Barrett, 2003; C. Twyman et al., 2004). A.J. Tenge et al. (2004) for example revealed for their study about adoption of soil and water conservation measures in Tanzania, that involvement in off-farm activities negatively influenced the adoption of measures because of the competition of labor between conservation measures and off-farm activities. For the CSS, this relation would probably be strongest related to wage labor.

When it comes to wage labor, one has to point out, that it is illusionary to aim at replacing wage labor on the long run because it is an important economic part of farming activities and partly also serves as a buffer and fall-back for the poor and middle income families if no other money can be made available (USAID, 2008). Thus, in the process of development, the dynamics of wage labor need to be included. If wage labor shall be reduced, alternatives need to be found for both, the rich and the poor. For the moment, the focus should rather be on improving working conditions. Although this highly depends on the goodwill of the employer, governance structures in the villages may partly contribute to improvements and restrict the exploitation of laborers. Furthermore, Moser and Barrett (2003) point to possible spillover effects of introducing beneficial but labor-intensive technologies to bigger farms. Although this would not directly impact the poor, the researchers elaborate that it would lead to higher labor demand in the villages and hence, higher wages, which could prove to be more effective than increasing smallholder productivity directly (C.M. Moser, C.B. Barrett, 2003).

Land

Land is partly handed over through inheritance. In contrast to other studies of for example E.L. Molua (2011) and D.J. Panell (1999), property rights are less a general problem but specific to women and specific to the village Changarawe. Women's' access to land is especially constrained as they do not obtain own property during marriage. Enforcement power of women, when it comes to their land rights seems to be low and not supported by internal governance structures in the villages. The insecure land rights for fertile land in Changarawe make long term investments not feasible for the farmers. Low fertility of surrounding areas increases the demand to enhance per acre productivity. However, Shiferaw et al. (2009) point out that resource-poor farmers are unlikely to adopt innovations that do not provide short-term economic gains, especially when property rights are imperfect to support investments with long payback periods.

Strategies in all villages to increase soil fertility are underdeveloped. S.J. Carr (2001) emphasizes that in fact, in African countries there is few tradition on restoration

measures for soil fertility in continuous cultivation. Traditional farming systems used to work with shifting cultivation and the switch to new techniques took place in short notice (S.J. Carr). In Dodoma CSS, an integrated crop-livestock system could improve the nutrient cycle (compare point 5.2.3, IFAD, 2010). Nevertheless, since livestock is a rare asset of the poor, especially in Morogoro, alternatives need to be found. Low external input practices of conservation agriculture and organic agriculture could be of help. However, one needs to evaluate well, which practices are worth to be promoted as they often have a high labor demand, high land demand and high demand for managerial skills (A. J. Tenge et al., 2004, A. Graves et al. 2004). Furthermore, benefits, for example in increased soil fertility, often take long to become manifested in yields, what is unattractive for many farmers (A. Graves et al., 2004). Interesting would be to tie new management ideas to practices that are already done on the field, for example intercropping. Recently, intercropping is mainly done for spacial constraints. Nevertheless, it offers the opportunity to introduce farmers to the nutritional dimension of intercropping. The trial would not create any losses for the farmer.

5.2.2.2 Current reasons for losses

The ideas promoted in the previous points already have implications for problems along the whole value chain that lead to yield losses. As results of point 4.3 revealed, especially the poor face connected problems along the whole value chain. Figure 15 illustrates one possible chain of problems (excluding marketing, to be discussed in point 5.2.2.3) for the poor as reported by participants.

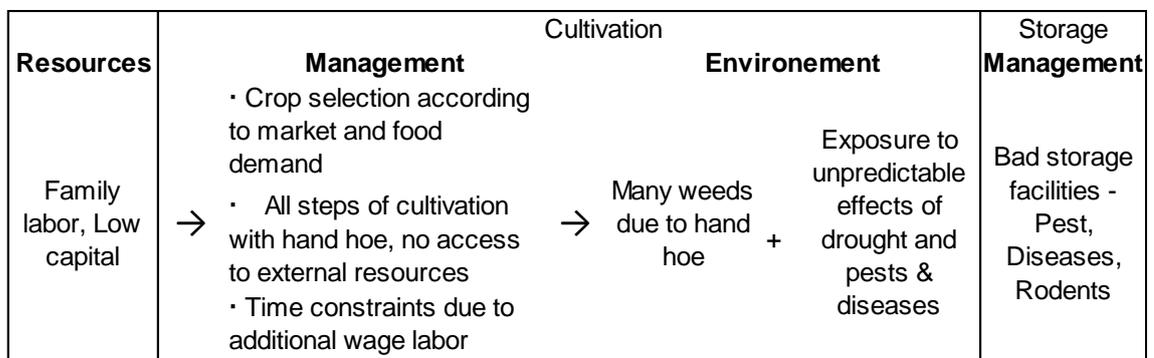


Figure 15 Example of a chain of problems in crop farming of a poor farmer

Figure 15 highlights that for the poor, major areas of concern are resource constraints of capital and labor (compare point 5.2.2.1) with resulting losses due to limited time and the unbuffered exposure to environmental factors, affecting as well storage facilities. Viglizzio (1994) elaborates that low external input systems, in order to be efficient, productive and sustainable, need to buffer or respond to two types of disturbance; the first is the regular seasonal rhythm of climate and prices and the second are unpredictable disturbances like weather events, pest and diseases or economic forces. Modern smallholder farmers of low external input systems in the CSS seem to be overwhelmed with the given unpredictable disturbances. Hence, current yield losses are first of all, due to poor management and unpredictable and unbuffered disturbances of the environment. Those environmental disturbances include in recent years especially the effects of drought and for certain crops and different regions pests and diseases (compare annex 2). Low-cost strategies to buffer effects are unavailable.

Management includes various issues e.g. timing and organization of field work as discussed in point 5.2.2.1. Some of the management decisions could potentially already counteract losses due to drought or pests and diseases, among them the crop selection. The vulnerability to losses is even increased by the tendency to align crop selection with market demand, thereby reducing the number of different field crops. The less crops are grown the higher the risk for failure if one crop is affected e.g. by drought or pests and diseases. And, the less crops grown and the less crop rotation the more soil degradation and susceptibility to potential pests and diseases for crops grown on the same plot over several years. Those management decisions hence, create spillover effects that render own resources less efficient and harm sustainability. Especially in Changarawe, it was perceived that the variety of crops on the field is small. Crop selection, if not appropriate for the local environment, can furthermore, increase capital demand, as it is for example the case for sesame in Morogoro that has a superior pesticide demand in order to be productive at all in the region. But market demand is setting the incentives for production (J.A. Andersson, S. D'Souza, 2014), which probably led to the high adoption of sesame in Morogoro. Also for Southern African countries, Andersson and D'Souza (2014) reported that a limited legume market in combination with a strong household demand is undermining crop rotation with legumes, a strategy that was promoted as conservation measure. It will be a challenge to find sufficient solutions that satisfy both, market demand and environmental potential.

Management can as well include the decision for one or the other storage facility. At this level, losses due to pests, diseases and rodents were reported to be high. Improved storage starts, according to participants reports, already with the preparation of the harvest on the field. Improved storage strategies and facilities should be included in any improvement strategy focusing on output, because any additional output obtained is not of help if it is lost in the end due to the mentioned forces.

For those and further management issues an important source of information in all CSS is the local extension officer, who is providing farmers with solutions to their problems on the field. This is going along with the findings of Ghadim and Pannell (1999), Moser and Barrett (2003) and Tenge (2004) who describe extension officers as trustworthy and helpful middleman that can play a key role in increasing learning and knowledge effects. Moser and Barrett (2003) furthermore, point out that in general learning effects play a major role on various levels: For farmers' initial decisions to try a new technology, the subsequent decisions as to what proportion of their cultivated area to put into the new method and to the latest, whether or not to continue with the method in future years. Therefore, it will be in the interest of the whole project to not only work in a participative and cooperative manner with the farmers but also to work close together with the extension officer and to train him or her in low-cost management alternatives. This will assist in transferring information best to a wide range of people also on the long run.

5.2.2.3 Marketing

On the one hand, increased yields, on the other hand, improved marketing channels can contribute to reach the final goal of higher monetary output of farming activities. Shiferaw et al. (2009) claim that improved market access is often the driving force for adoption of innovations in agriculture.

Farmers were reporting very often about the finally low prices they obtain for their harvest. This is especially due to information asymmetries in favor of local traders and low bargaining power of single farmers. Strategies need to be found to equalize the situation between farmers and traders. One has to point out that the project has only the possibility to do so on the farm and village level, although supra-regional traders may contribute a lot to the recent situation. Therefore, the position of the farmers needs to be strengthened e.g. by developing networks to supply farmers with market information. This would result as well in better bargaining power of the farmer because he or she would be aware of recent possible prices. Also here the formation of marketing groups could be of potential help, although records reveal varying levels of success for different regions (T. Bernard et al., 2007). Its potential benefits can include that goods could be stored and traded in bigger quantities which would be to the benefit of both, the trader and the farmer. The trader could lower transport and transaction costs⁹ and the farmer could potentially benefit from better prices because of an improved bargaining position. This benefit was already recognized by a sesame trading group in Ilolo but yet, did not have spillover effects for other crops because organization of the group was reported to be rather complex.

To summarize, the chain of problems of the poor farmers describes how to prioritize different innovational strategies and reveals an outline of possible constraints and entry points for innovation. One can realize that resource limitations, most notably capital limitations, of the poor enhance current losses and furthermore, undermine farm management especially in terms of timing. Sources that would provide information on alternative farming schemes are narrow inside the villages. Power inequalities in marketing are offering limited opportunities for the poor to increase capital through crop marketing. Especially the formation of groups was identified to be beneficial to overcome several of these problems. However, as groups are not naturally part of local farming systems their introduction would need effort and the provision of skills for capacity building among the farmers. During all steps of improvement it will be important to actively involve women, because they are usually the ones who are restricted in access to resources and new technologies. Furthermore, giving them an active role in development and information provision could build women's' capacity by on the one hand, enhancing women empowerment through an increase in self-confidence and community respect and on the other hand, providing them with access to professional information (J. Njuki et al., 2013).

⁹ Transaction costs: The cost associated with the exchange of goods or services and incurred in overcoming market imperfections, ex ante e.g. search and information costs, bargaining costs; ex post e.g. policing and enforcement costs (P.M. Johnsen, 2005)

5.2.3 The role of livestock

Within the whole system, livestock is playing a secondary role. Livestock and crop production rather coexist in this diversified system and thus, all livestock is mainly kept for income reasons (IFAD, 2010). High value livestock such as cattle and ruminants generate a regular part of the wealthier household's income. Some smaller ruminants and especially poultry are kept as financial fallback resource for times of need. Especially in Dodoma livestock is taking over an important position. Because of the unpredictable conditions for crop farming activities the need for a financial buffer is high to limit the risk of poverty. Capital investments are highest into cattle and pigs

The availability of livestock in Dodoma is holding the opportunity to further integrate livestock and farming activities. An integration of livestock and crop farming is leading to a cyclic system with waste management of crop residues as fodder on the one hand, and nutrient and power supply for crop farming, on the other hand. This synergy of crop and livestock leads to an effective use of resources through recycling of available resources and can minimize as well negative environmental effects of high livestock densities (IFAD, 2010). However, it demands for a challenging introduction of various new management techniques that build on each other e.g. the introduction of improved storage facilities (IFAD, 2010). Although in Dodoma some farmers already recognized the value of using organic fertilizer, it is still not common practice. Therefore, the systems should be supported.

This is not an option for Morgoro CSS as the conflict between livestock keepers and farmers is persistent and deep-rooted. Affected are mainly ruminants. Nevertheless, also here the use of organic fertilizer could be encouraged due to the high density of chicken. But in order to collect their feces, new stabling ideas would need to be developed. Thievery and predators are common fears in relation to chickens, and should be considered in the design of the stables (especially overnight arrangements). Integrated poultry-crop systems could be especially interesting for many women because they are the primary responsible for chicken. Important for women are also pigs, because they remain in the stable near the house all year but their keeping is mainly constrained by unstable markets in both regions.

The strongest problems expressed related to livestock keeping were those regarding feeding of the animals and the availability and accessibility of pharmaceuticals and proper information on certain diseases. Hence, they are very similar to some problems in crop farming and are covering the topics of: drought effects, capital demand, input market demand and information demand to keep track with modern changes. To make livestock keeping more independent from outside forces and the market a stronger integration with crop farming and information supply on management and medical issues could be of help.

6 Conclusion

This study aimed at undertaking an ex-ante participative situation analysis to identify together with farmers, context specific constraints and opportunities for the later design and uptake of innovations along the food value chain in the CSS.

Describing and analyzing the situation of the respective farming system gave insights into farmers' ways of thinking, their ideas, demands and constraints that will be important for further project design. This study did not intend action but assists in identifying possible areas for action. In this sense the chosen actor oriented participative approach, through the use of communication tools and personal discussion in workshops was able to answer the research questions. Its obstacles were discussed in point 5.1. Future research should build on the experience of this study to make efficient use of time and to build communication structures that involve all actors actively.

Results and discussion demonstrated important relations that shape possible entry points for innovations along the food value chain and led to the following conclusions.

In all villages, crop farming is the most important livelihood activity. Only for some farmers, livestock keeping is an additional activity to crop farming because it demands for a certain investment for which capital is mostly generated through crop farming. Differences in livestock keeping occur on the regional level and due to cultural differences between the traditionally livestock keeping Gogo tribe in Dodoma and traditional crop farmers in Morogoro. Crop farming is not only undertaken for subsistence but as well for generating a substantial amount of income. Even poor farmers make an opportunity cost based decision about which part of the harvest to sell and which part to keep. Alternative income opportunities are limited in all villages. Differences on the village and even sub-village level are mostly due to differences in infrastructure. The importance of crop farming highlights that in order to improve and sustain livelihoods, innovations need to target at problems along the crop value chain to improve both, food availability and the capital situation of farmers.

In general, along the crop value chain innovations can enter on three levels: Addressing resource limitations, addressing current reasons for production and post-harvest losses and optimization of marketing. Those can help to secure the harvest with given resources, to increase the output per area and/or to increase the financial output per yield.

To reveal limits to those potential points of entry for innovations, one needs to have a closer look at the target group for innovations in crop farming. All farmers suffer from the increasingly unpredictable climate and pest as well as disease pressure. Especially drought scenarios increased during the last years. Given these changes, the medium to low income groups of farmers are especially affected by problems along the whole crop value chain. In contrast to wealthier farmers, they only have few options to make up for losses, especially in financial terms, through other income generating activities or to optimize production conditions through the use of external inputs. Their biggest

constraint lies on the resource level, with strong limitations especially in labor and capital. Particularly women suffer from low access to resources, high workloads and less access to markets. The high number of single female households in all CSS is, hence, especially in danger of poverty. The poor to medium income farmers use their labor and capital resources to their limits. This has a strong implication for the identification of innovation. The restrictions in capital and labor thus, create a trap for straight forward innovation identification. Innovations can neither be labor nor capital demanding but rather need to focus on solving those problems as they are the biggest constraints to improvements. Furthermore, with given limited resources innovations need to be of low risk for the farmer and should be easy to be embedded into ongoing processes. This informs on how to prioritize different solutions and creates the need to develop innovations beyond the pure farm level.

Resource limits lead to connected and related problems along the whole crop value chain up to marketing, which finally results in farmers struggling to maintain their most important livelihood activity, crop farming. Therefore, innovation strategies for the poor to medium income farmers shall not only tackle single problems but need to be connected and supportive of the whole system to reach an overall target and to be sustainable in the long run.

This study reveals that participatory research can make a big contribution in elucidating farmers' resource allocation strategies, problems perception and underlying context-cause-effect understanding that is highly site specific and essential for developing any innovation strategy. Further research should focus on, first, more socio-anthropological research to differentiate more clearly between different farmer sub groups, which will help for, second, understanding farmers' specific decision structures, which depend on various tacit and non-tacit factors. Some site-specific factors were revealed by this study but the degree of their importance and how they may finally affect the decision on innovation adoption goes beyond the scope of this study. This point also demands for understanding which factors farmers will ultimately pay attention to when evaluating the success of a change in practice because farmers' means to recognize benefits are very different to those of researchers and so is their perception of the innovation. At given levels of information, it would be important that potentially feasible innovations create an immediately obvious benefit to the farmer. If the benefit, e.g. a soil nutrient increase, can be measured by the scientist but does not result in any straight-forward benefit to the farmer after trial, final uptake of innovation will most likely remain low.

This finding demands for a continued participative research process to involve farmers actively. Thereby, the research process will be made more transparent. Farmers would get the opportunity to understand as well the researchers' underlying logics, and not only vice versa, to learn about and contribute to the project development so that possible outcomes will be less uncertain and more evaluable to them. Finally, active participation could thereby counteract possible false expectations on the project and its outcome.

7 Summary

Tanzanian smallholder farmers are increasingly confronted with unpredictable climate, increasing food demand and rural poverty. There is a strong need to improve Tanzanian smallholder agricultural production systems and thereby, to increase production, to increase system's resilience against future hazards and to improve rural livelihoods. Potential innovations need to respond to local needs and need to fit both, the site specific context and the capabilities of people involved in order to be effective, as there is no "one size fits all" solution.

This study conducts a participatory ex-ante situation analysis, which aims to identify potential points of entry for innovations by investigating context specific demands, constraints and opportunities for the uptake of innovations from the farmer's point of view. Issues of difference and underlying relations and logics of the context shall be revealed by recognizing different livelihood strategies and regional and socio-economic variations in resource endowment.

Field data collection was carried out from January until April 2014 in four representative case study sites in the Morogoro (semi-humid) and Dodoma (semi-arid) regions of Tanzania. Participatory methods combine livelihood analysis with a collective assessment of agricultural activities. Per village, approximately 100 people participated in 14 group sessions using livelihood illustration and charting, net maps and problem trees as tools in groups segregated by gender. Resource maps and seasonal calendars were developed with mixed groups.

Results show that livelihood in all CSS is centered on agricultural activities on small holder farms which is the major source of both, food and income for the families. Other income opportunities are limited and restricted to some wealthier families. This lack of diversification leads to increased vulnerability as the agricultural sector becomes increasingly erratic from environmental volatilities in both, semi-humid Morogoro and semi-arid Dodoma. Especially affected by those volatilities are low to medium income groups of farmers as they lack the means to influence production conditions. Among others, those include single-female-HH and old people. In years of drought, even the medium income groups are sometimes not able to generate enough food and income by crop farming, which is forcing them into a vicious cycle with wage labor that is even affecting the farming practices of the next year. Low to medium income farmers use their resources of labor, land and capital to the limits. Restrictions in resources are according to the farmers, the main reasons for connected problems in production and marketing along the crop value chain.

The study concludes that innovations need to target on connected problems along the crop-value chain for low to medium income farmers. Potential entry points should focus on: addressing resource limitations, addressing current reasons for losses and optimization of marketing. Given resource limitations, potential innovations can neither be capital nor labor demanding and should generate straight-forward benefits to the farmer. Innovations should focus on solving resource limitations by finding connected solutions that build on each other and tackle problems along the value chain in support of the whole farming system. An actor oriented approach for the development of innovation strategies is recommended.

References

ACKOFF, R. (1999): *Ackoff's best. His classic writings on management.* New York: Wiley.

AGRAWAL, A. (2004): Indigenous and scientific knowledge: some critical comments. In: *IK Monitor* (3), S. 1–9.

AMERICAN MARKETING ASSOCIATION (2014): Dictionary. Available at: <https://www.ama.org/resources/Pages/Dictionary.aspx?dLetter=S&dLetter=S>, entered 22.11.2014.

ANDERSSON, J. et al. (2005): Tanzania- Environmental policy brief. Available at: <http://sidaenvironmenthelpdesk.se/wordpress3/wp-content/uploads/2013/04/Env-Policy-Brief-Tanzania-2005.pdf>, entered 08.10.2014.

ANDERSSON, J. A.; D'SOUZA, S. (2014): From adoption claims to understanding farmers and contexts: A literature review of Conservation Agriculture (CA) adoption among smallholder farmers in southern Africa. In: *Agriculture, Ecosystems & Environment* 187, pp. 116–132.

ARNDT, C. et al. (2012): Climate Change, Agriculture and Food Security in Tanzania. In: *Review of Development Economics* 16 (3), pp. 378–393.

ASFG (2010): *Africa's smallholder farmers Approaches that work for viable livelihoods.*

AUSTRALIAN GOVERNMENT, PRODUCTIVITY COMMISSION (2013): *On efficiency and effectiveness: some definitions.* Staff Research Note, Canberra.

BEETS, W.C. (1990): *Raising and sustaining productivity of smallholder farming systems in the tropics.* AgBe Publishing, Alkmaar, Holland.

BERNARD, T. et al. (2007): Smallholders' commercialization through cooperatives. A diagnostic for Ethiopia. In: IFPRI Discussion paper 00722.

BOSCH, O. J. H. et al (2007): Getting the big picture in natural resource management-systems thinking as 'method' for scientists, policy makers and other stakeholders. In: *Syst. Res.* 24 (2).

CARR, S.J. (2001): Changes in African Smallholder Agriculture in the Twentieth Century and the Challenges of the Twenty-First. In: *African Crop Science Journal*, Vol. 9, No. 1, pp. 331-338.

CHAMBERS, R. (1994): The Origins and Practice of Participatory Rural Appraisal. In: *World Development Vol.22* (7), pp. 953–969. (a)

- CHAMBERS, R. (1994): Participatory Rural Appraisal (PRA): Analysis of Experience. In: *World Development Vol.22* (9), pp. 1253–1268. (b)
- CHAMBERS, R. et al. (1989): *Farmer First: Farmer Innovation and Agricultural Research*. IT Publications, London.
- CHAMBERS, R.; GHILDYAL, B.P. (1984): Agricultural Research for Resource-Poor Farmers: The Farmer-First-and-Last Model. In: Ford Foundation Discussion Paper no 16, New Delhi: Ford Foundation.
- CONROY, C. (2001): Participatory situation analysis with livestock keepers: A guide. NRI-BAIF publication.
- CORNWALL, A. (2003): Whose Voices? Whose Choices? Reflections on Gender and Participatory Development. In: *World Development* 31 (8), pp. 1325–1342.
- CORNWALL, A. (1998): Gender, participation and the politics of difference. In: Guijt, I., Kaul Shah, M. (Eds.): *The Myth of Community: Gender Issues in Participatory Development*. Intermediate Technology Publications Ltd, London, pp. 46–57.
- CORNWALL, A.; FLEMING, S. (1995): Context and complexity: anthropological reflections on PRA. In: *PLA Notes* 24, pp. 8–12.
- CORNWALL, A.; GUIJT, G.; WELBOURN, A. (1993): Acknowledging process: Challenges for agricultural research and extension methodology. Discussion paper 333, Institute of development studies, Brighton, UK.
- CORNWALL, A.; PRATT, G. (2003): Pathways to Participation: Critical reflections on PRA. In: *London: Intermediate technology publications*.
- CORNWALL, A.; PRATT, G. (2010): The use and abuse of participatory rural appraisal: reflections from practice. In: *Agric Human Values*, pp. 263 – 272.
- CROPPENSTEDT, A. et al. (2013): Gender and Agriculture: Inefficiencies, Segregation, and Low Productivity Traps. In: *The World Bank Research Observer* 28 (1), pp. 79–109.
- DARNHOFER, I. et al (eds.) (2012): *Farming Systems Research into the 21st Century: The New Dynamic*. Dordrecht Heidelberg New York London: Springer.
- DE JAGER, A. et al (2001): Assessing sustainability of low-external-input farm management systems with the nutrient monitoring approach: a case study in Kenya. In: *Agricultural Systems* (69), pp. 99–118.
- DFID (2003): *Tools for Development: A handbook for those engaged in development activity*. Available at:

- <http://webarchive.nationalarchives.gov.uk/+http://www.dfid.gov.uk/Documents/publications/toolsfordevelopment.pdf>, entered 10.12.2013.
- DILLON, J.L. (1992): The farm as a purposeful system. Miscellaneous Publication, The University of New England, Armidale, Australia, pp. 5-10.
- ELLIS, F. (2000): Rural Livelihoods and Diversity in Developing Countries. Oxford University Press, Oxford, UK.
- ELLIS, F. (2003): Livelihoods and Rural Poverty Reduction in Tanzania. In: *World Development* (Vol. 31, No. 8), pp. 1367–1384.
- EMBASSY OF THE UNITED REPUBLIC OF TANZANIA IN GERMANY (2014): Geography and culture. Available at: <http://www.tanzania-gov.de/tanzania/geography-culture>, entered 26.09.2014.
- ERICKSEN, P.J. (2008): Conceptualizing food systems for global environmental change research. In: *Global Environmental Change* 18 (1), pp. 234–245.
- FAO (2014): Promoting the Growth and Development of Smallholder Seed Enterprises for Food Security Crops: Case studies from Brazil, Côte d'Ivoire and India. In: FAO plant production and protection paper 201. Rome, Italy.
- FAO stat (2014): United republic of Tanzania. Available at: <http://faostat3.fao.org/browse/area/215/E>, entered 26.11.2014.
- FAO (2004): Framework for analyzing impacts of globalization on smallholders. Available at: <http://www.fao.org/docrep/007/y5784e/y5784e02.htm>, entered: 23.11.2014.
- FAO (2004): WHAT IS LOCAL KNOWLEDGE?. Fact sheet as part of the Training Manual "Building on Gender, Agrobiodiversity and Local Knowledge". Available at: <http://www.fao.org/docrep/007/y5610e/y5610e01.htm>, entered 09.11.2014.
- FAÏE, A. et al. (2014): Household survey wave 1. Trans-SEC.
- FEDER, G. et al (1985): Adoption of Agricultural Innovations in Developing Countries: A Survey. In: *Economic development and cultural change Vol.33* (2), pp. 255–298.
- FEDER, G.; UMALI, D. L. (1993): The Adoption of Agricultural Innovations A Review. In: *Technological Forecasting and Social Change* (43), pp. 215–239.
- FELDMAN, S.; WELSH, R. (1995): Feminist Knowledge Claims, Local Knowledge, and Gender Divisions of Agricultural Labor: Constructing a Successor Science. In: *Rural Sociology*, Volume 60, Issue 1, pp. 23–43.

FERNANDEZ, M. (1994): Gender and indigenous knowledge. In: *Indigenous knowledge and development monitor Vol. 2* (3), pp. 6–8.

FOLEY, J.A. et al. (2011): A solution for a cultivated planet. In: *Nature*, Nr. 478, pp.337-342.

GHADIM, A.K.A.; PANNELL, D. J. (1997): A Conceptual Framework of Adoption of an innovation including dynamic learning, personal perceptions and risk attitudes. Presented at the 41. Annual Conference of the Australian Agricultural and Resource Economics Society, Gold Coast, Queensland.

GRAEF, F. et al (2013): Innovating Strategies to safeguard Food Security using Technology and Knowledge Transfer: A people-centred Approach. Trans-Sec Proposal.

GRAVES, A. et al (2004): Low external input technologies for livelihood improvement in subsistence agriculture. In: *Advances in Agronomy* (82), pp. 473–555.

HAGGBLADE, S.; HAZELL, P.B.R. (2010): Success in African agriculture: lessons for the future. International Food Policy Research Institute, John Hopkins University Press, Baltimore.

HULME, M., et al (2001): African climate change: 1900–2100. In: *Clim. Res. Nr. 17*, pp. 145–168.

IFAD (2014): Higher and volatile food prices and poor rural people. Available at: <http://www.ifad.org/operations/food/>, entered 19.11.2014.

IFAD (2010): Integrated crop-livestock farming systems. Available at: <http://www.ifad.org/lrkm/factsheet/integratedcrop.pdf>, entered 05.01.2014.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN) (nd.) Situation Analysis – An Approach and Method for Analyzing the Context of Projects and Programme. Available at: http://cmsdata.iucn.org/downloads/approach_and_method.pdf, entered 30.11.2014.

JOHNSON, P.M. (2005): Transaction costs. In: A glossary of political economy terms. Available at: http://www.auburn.edu/~johnspm/gloss/transaction_costs, entered 06.01.2014.

KAUFMANN, B. et al. (2013): From assessing knowledge to joint learning. In: A. Christinck and M. Padmanabhan (eds.): *Cultivate Diversity! A handbook on transdisciplinary approaches to agrobiodiversity research*. Margraf Publishers, Scientific Books, Weikersheim, Germany.

KAUFMAN, B. et al. (2013): Local knowledge. Seminar at the University of Kassel, Germany, December 2013.

- KAUFMANN, B. (2007): Cybernetic analysis of socio-biological systems: The case of livestock management in resource-poor environments. Weikersheim: *Margraf Publishers GmbH*, pp. 31–37.
- KEPAS (1983): The Sustainability of Agricultural Intensification in Indonesia. A report of the workshop of the Research Group Iarkata.
- KNOEMA (2006): Dodoma – Life expectancy at birth.
Available at: <http://knoema.de/atlas/Vereinigte-Republik-Tansania/Dodoma/Life-Expectancy-at-Birth>, entered 15.12.2014.
- KNOEMA (2006): Morogoro – Life expectancy at birth.
Available at: <http://knoema.de/atlas/Vereinigte-Republik-Tansania/Morogoro/Life-Expectancy-at-Birth-Male>, entered 15.12.2014.
- KOMBA, C.; MUCHAPONDWA, E. (2012): Adaptation to Climate Change by Smallholder Farmers in Tanzania. In: *ERSA working paper (299)*, pp. 1–32.
- KRANZ, L. (2001): The Sustainable Livelihood Approach to Poverty Reduction. An introduction. Swedish international development cooperation agency.
- KRUMMACHER, A. (2004): Der Participatory Rural Appraisal (PRA)-Ansatz aus ethnologischer Sicht. PRA – a quick and dirty anthropology? In: *Arbeitspapiere / Working Papers Nr.36*. Institut für Ethnologie und Afrikastudien, Johannes Gutenberg-Universität, Mainz.
- MARCH, C. et al. (1999): A Guide to Gender-Analysis Frameworks. Oxfam publication, Oxford, UK.
- MCCAULEY, A.P. et al (1992): Household decisions among the gogo people of Tanzania: Determining the roles of men and women and the community in implementing a trachoma prevention program. In: *Soc.Sci.Med. Vol. 34 (7)*, pp. 817–824.
- MOLNAR, A. (1991): Rapid Rural Appraisal Methodology Applied to Project Planning and Implementation in Natural Resource Management. In: John van Willigen and Timothy L. Finan (eds.), *Soundings: Rapid and Reliable Research Methods for Practicing Anthropologists*; pp.11-23. o.O.: National Association for the Practice of Anthropology.
- MOLUA, ERNEST L. (2011): Farm income, gender differentials and climate risk in Cameroon: typology of male and female adaptation options across agroecologies. In: *Sustain Sci* 6 (1), pp. 21–35.
- MOMSEN, J.H. et al. (2013): Agrobiodiversity and equity: Addressing gender in transdisciplinary research. In: In: A. Christinck and M. Padmanabhan (eds.): *Cultivate*

Diversity! A handbook on transdisciplinary approaches to agrobiodiversity research. Margraf Publishers, Scientific Books, Weikersheim, Germany.

MORTON, J. F. (2007): The impact of climate change on smallholder and subsistence agriculture. In: *PNAS*, Vol. 104, Nr. 50, pp. 19680–19685.

MOSER, C. M.; BARRETT, C. B. (2003): The Complex Dynamics of Smallholder Technology Adoption: The Case of SRI in Madagascar. In: *Working paper 2003-20, Department of Applied Economics and Management Cornell University, Ithaca, New York*.

MSUYA, E.E. et al (2008): Explaining Productivity Variation among Smallholder Maize Farmers in Tanzania. In: *MPRA Paper* (14626).

MUTABAZI, K.D. (2013): Identifying, defining and typologizing FVC and upgrading strategies. Work package 3, Trans-SEC.

NAGAYETS, O. (2005): Small farms: Current status and key trends. Information Brief, Prepared for the Future of Small Farms Research Workshop Wye College, June 26–29, 2005.

NJUKI, J. et al (2013): Increasing the Productivity and Empowerment of Women Smallholder Farmers: Results of a Baseline Assessment from Six Countries in Africa and Asia. Care.

Available at: <http://www.care.org/sites/default/files/documents/pathways-global-baseline-report-2013.pdf>, entered 25.01.2015.

NOREM, R.H.R. et al. (1989): Indigenous agricultural knowledge and gender issues in third world agricultural development. pp.91-100 In: D.M. Warren, L.J. Slikkerveer and S.O. Titilola (eds): *Indigenous knowledge systems: Implications for agriculture and international development*. Studies in Technology and social Change Program No. 11. Ames, Iowa: Iowa State University Research Foundation.

OBERHAUSER, A.M. et al. (2004): Gendered livelihoods in diverse global contexts: an introduction. In: *Gender, Place & Culture: A Journal of Feminist Geography*, 11:2, pp. 205-208.

OGLE, B.R. (2001): The need for socio-economic and environmental indicators to monitor degraded ecosystem rehabilitation: a case study from Tanzania. In: *Agriculture, Ecosystems & Environment* (87), pp. 151–157.

OU DWATER, N.; MARTIN, A. (2003): Methods and issues in exploring local knowledge of soils. In: *Geoderma* (111), pp. 387–401.

PANNELL, D. J. (1999): Social and economic challenges in the development of complex farming systems. In: *Agroforestry Systems* (45), pp. 393–409.

- PADMANABHAN, M.A. (2002): *Trying to Grow: Gender Relations and Agricultural Innovations in Northern Ghana*. Lit Verlag, Münster.
- PARDUHN, D. (2011): 'Everyone is doing something and calling it PRA' A Critical Reflection on Participatory Methods in Development. Available at: <https://afrikawissenschaft.wordpress.com/2011/07/02/everyone-is-doing-something-and-calling-it-pra-a-critical-reflection-on-participatory-methods-in-development/>, entered 27.11.2014.
- PAAVOLA, J. (2008) Livelihoods, Vulnerability and Adaptation to Climate Change: Lessons from Morogoro, Tanzania. In: *Environmental Science & Policy* 11: 642-654.
- PENDO SCHÄFER, M. (2013): Tanzania travel report. Trand-SEC.
- PERCY, R. (1999): Gender analysis and participatory rural appraisal: assessing the current debate through an Ethiopian case study involving agricultural extension work. In: *International Journal of Educational Development* (19), pp. 395–408.
- RICHARDS, P. (1995): Participatory rural appraisal: a quick-and-dirty critique. In: *PLA Notes* 24, pp. 13–16.
- ROELEVELD, A.C.W.; BROEK, A. (1996): Focusing livestock systems research. In: *Royal Tropical Institute: Amsterdam*, pp. 14–28.
- ROWHANI, P. et al (2011): Climate variability and crop production in Tanzania. In: *Agricultural and Forest Meteorology* 151 (4), pp. 449–460.
- RQDA User's manual. Available at: http://rqda.r-forge.r-project.org/documentation_2.html, entered: 02.08.2014.
- RWEYEMAMU, D. (2009). Strategies for Growth and Poverty Reduction: Has Tanzania's Second PRSP Influenced Implementation?. In: *DIIS Working Paper 2009:13*. Copenhagen, Denmark.
- SALAS M. et al (1989): Training for PTD (Participatory technology development): crucial issues and challenges LBL. Lindau. Switzerland.
- SCHIFFER, E. (2008): Tracing Power and Influence in Networks: Net-Map as a Tool for Research and Strategic Network Planning. In: *IFPRI Discussion Paper* (00772).
- SCHÖNHUTH, M. (nd.): Mit den Augen des Ethnologen: Ethnologinnen und ihre Begegnung mit partizipativen Planungsmethoden - Drei Erfahrungsberichte. Available at: https://www.uni-trier.de/fileadmin/fb4/ETH/Aufsaeetze/Mit_den_Augen_Ethno.pdf, entered 10.11.2014.

- SHIFERAW, B. A.; OKELLO, J.; REDDY, R. V. (2009): Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. In: *Environ Dev Sustain* 11 (3), pp. 601–619.
- SCOONES, I. (1995): PRA and anthropology: challenges and dilemmas. In: *PLA Notes* 24, pp. 17–20.
- SPEEDING, C.R.W. (1988): An introduction to agricultural systems. Elsevier, London, pp. 15-19.
- SPIELMAN, D. J.; EKBOIR, J.; DAVIS, K. (2009): The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture. In: *Technology in society* (31), pp. 399–405.
- SWEENEY, C. et al (2010): UNDP Climate change country profile: Tanzania. Available at:
http://www.geog.ox.ac.uk/research/climate/projects/undpcp/UNDP_reports/Tanzania/Tanzania.lowres.report.pdf, entered 08.10.2014.
- TEMU, A. E.; DUE, J. M. (2000): Participatory appraisal approaches versus sample survey data collection: a case of smallholder farmers well-being ranking in Njombe district, Tanzania. In: *Journal of African Economies Vol.9* (1), pp. 44–62.
- TENGE, A. J. et al (2004): Social and economic factors affecting the adoption of soil and water conservation in West Usambara highlands, Tanzania. In: *Land Degrad. Dev.* 15 (2), pp. 99–114.
- THIELE, G. (1986): The Tanzanian Villagisation Programme: Its Impact on Household Production in Dodoma. In: *Canadian Journal of African Studies / Revue Canadienne des Études Africaines*, Vol.20, No. 2 , pp. 243-258.
- THOMAS, A. (2013): Situation analysis in participatory/transdisciplinary projects. Experiences from the BMBF funded project "Kulturlandschaft Hohenlohe". Witzenhausen, November 2013.
- THURLOW, J.; WOBST, P. (2003): Poverty-focused social accounting matrices for Tanzania. In: TMD discussion papers 112, International Food Policy Research Institute (IFPRI).
- TWYMAN, C. et al (2004): 'Where is the life in farming?': The viability of smallholder farming on the margins of the Kalahari, Southern Africa. In: *Geoforum* 35 (1), pp. 69–85.
- URT (2012): NATIONAL SAMPLE CENSUS OF AGRICULTURE 2007/2008. Volume Va: REGIONAL REPORT: DODOMA REGION. Tanzania.

URT (2012): NATIONAL SAMPLE CENSUS OF AGRICULTURE 2007/08. Volume Ve: REGIONAL REPORT: MOROGORO REGION. Tanzania.

URT (2007): Poverty and human development report 2007. Research and Analysis Working Group (R & AWG), United Republic of Tanzania. Dar es Salaam, Tanzania

URT (2009): Poverty and human development report 2009. Research and Analysis Working Group (R & AWG), United Republic of Tanzania. Dar es Salaam, Tanzania.

URT (2005): National strategy for growth and reduction of poverty (NSGRP).Tanzania.

U.S. CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT (1988): Enhancing Agriculture in Africa: A role for U.S. development assistance. U.S. Government Printing Office, Washington D.C.

USAID (2008): Preliminary rural livelihood zoning: Tanzania. A special report by the famine early warning system network (fews net). Dar es Salaam, Tanzania.

VAN NES, F. et al. (2010): Language difference in qualitative research: is meaning lost in translation?. In: European journal of ageing 7 (4), pp. 313-316.

VEDELD, P. et al (2012): Protected areas, poverty and conflicts: A livelihood case study of Mukumi National Park, Tanzania. In: Food Policy and Economics (21), pp. 20–31.

VIGLIZZO, E. F. (1994): The Response of Low-Input Agricultural Systems to Environmental Variability. A Theoretical Approach. In: *Agricultural Systems* (44), pp. 1–17.

WAGURA NDIRITU, S. (2014): Are there systematic gender differences in the adoption of sustainable agricultural intensification practices? Evidence from Kenya. In: Food Policy (49), pp. 117-127.

WARREN, D.M. (1989): The impact of nineteenth century social science in establishing negative values and attitudes toward indigenous knowledge systems. In: D.M. Warren, L.J. Slikkerveer and S.O. Titilola (eds.) *Indigenous knowledge systems: Implications for agriculture and international development*. Studies in Technology and Social Change Program No. 11. Ames, Iowa: Iowa State University Research Foundation.

WEBBER, L.M.; ISON, R.L. (1995): Participatory rural appraisal design: conceptual and process issues. In: *Agricultural Systems* 47, pp. 107-131.

ZIERVOGEL, G., ERICKSEN, P. J. (2010): Adapting to climate change to sustain food security. In: *WIREs Climate Change*, 1, pp. 525-540.

Annex

1 Reference and list of participation in workshops

Date	Time	Region	Village	Subvillage	Activity	Women	Men	Total
21.01.2014	AM	Dodoma, Chamwino	Ilolo	mix	Resource map	4	4	8
21.01.2014	PM	Dodoma, Chamwino	Ilolo	mix	Satelite map	4	4	8
22.01.2014	AM	Dodoma, Chamwino	Ilolo	Sabasaba	Livelihood Part 1	2	4	6
22.01.2014	PM	Dodoma, Chamwino	Ilolo	Mapenduzi	Livelihood Part 2	6	4	10
23.01.2014	AM	Dodoma, Chamwino	Ilolo	Sokoine	Crop calendar Part 1	4	4	8
24.01.2014	AM	Dodoma, Chamwino	Ilolo	Malazela	Livestock calendar: goat, cattle	6	3	9
29.01.2014	PM	Dodoma, Chamwino	ldifu	mix	Resource map	2	2	4
30.01.2014	AM	Dodoma, Chamwino	ldifu	Mmoja	Net map women	6	0	6
30.01.2014	PM	Dodoma, Chamwino	ldifu	Nyere	Net map men	0	6	6
31.01.2014	AM	Dodoma, Chamwino	ldifu	Chinyika	Problem tree crop women	6	0	6
31.01.2014	PM	Dodoma, Chamwino	ldifu	Salabwe	Problem tree crop men	0	7	7
01.02.2014	AM	Dodoma, Chamwino	ldifu	Nnanga	Resource map sub village	1	2	3
01.02.2014	AM	Dodoma, Chamwino	ldifu	Nnanga	Problem tree livestock men	2	10	12
04.02.2014	PM	Dodoma, Chamwino	ldifu	Msejelela	Livelihood women Part 1	6	0	6
05.02.2014	PM	Dodoma, Chamwino	ldifu	Muyangwe	Livelihood men Part 1	0	6	6
06.02.2014	AM	Dodoma, Chamwino	ldifu	Lusinde	Livelihood women Part 2	6	0	6
06.02.2014	PM	Dodoma, Chamwino	ldifu	mix	Interview: Women farmer group	5	0	5
07.02.2014	AM	Dodoma, Chamwino	ldifu	Chigiha	Problem tree livestock women	6	0	6
10.02.2014	PM	Dodoma, Chamwino	ldifu	Isangia	Crop calendar Part 1	3	4	7
11.02.2014	PM	Dodoma, Chamwino	ldifu	Chiseyu	Crop calendar Part 2	6	1	7
11.02.2014	PM	Dodoma, Chamwino	ldifu	Chiseyu	Livelihood men Part 2	0	6	6
12.02.2014	PM	Dodoma, Chamwino	ldifu	Nyangwe	Livestock calendar:cow, goat	4	3	7
13.02.2014	PM	Dodoma, Chamwino	ldifu	Mungano	Livestock calendar: pig, chicken	6	2	8
14.02.2014	AM	Dodoma, Chamwino	ldifu	mix	Interview: farmer older than 65	2	2	4
18.02.2014	Am	Dodoma, Chamwino	Ilolo	mix	Problem tree crop women	5	0	5
18.02.2014	PM	Dodoma, Chamwino	Ilolo	mix	Problem tree crop men	0	6	6
19.02.2014	AM	Dodoma, Chamwino	Ilolo	mix	Net map women	6	0	6
19.02.2014	PM	Dodoma, Chamwino	Ilolo	Kivukoni	Net map men	0	6	6
20.02.2014	AM	Dodoma, Chamwino	Ilolo	Madaraka	Proplem tree livestock women	7	0	7
20.02.2014	PM	Dodoma, Chamwino	Ilolo	Nyerere	Problem tree livestock men	0	6	6
21.02.2014	AM	Dodoma, Chamwino	Ilolo	Lusinde	Livestock calendar: pig	1	7	8
21.02.2014	PM	Dodoma, Chamwino	Ilolo	mix	Crop calendar: vegetables	0	6	6
22.02.2014	AM	Dodoma, Chamwino	Ilolo	mix	Interview: Farmer groups	4	5	9

Date	Time	Region	Village	Subvillage	Activity	Women	Men	Total
14.03.2014	PM	Morogoro, Kilosa	Ilakala	mix, village lede	Resource map	0	4	4
15.03.2014	Am	Morogoro, Kilosa	Ilakala	Shuleni	Livelihood Part 1 men	0	6	6
15.03.2014	PM	Morogoro, Kilosa	Ilakala	Shuleni	Livelihood Part 1 women	6	0	6
17.03.2014	AM	Morogoro, Kilosa	Ilakala	Mihogony	Livelihood part 2 women	6	0	6
17.03.2014	PM	Morogoro, Kilosa	Ilakala	Mihogony	Livelihood part 2 men	0	6	6
18.03.2014	AM	Morogoro, Kilosa	Ilakala	Ilakala mashine	Netmap women	5	0	5
18.03.2014	PM	Morogoro, Kilosa	Ilakala	Ilakala mashine	Netmap men	0	6	6
19.03.2014	AM	Morogoro, Kilosa	Ilakala	Miembeny	Crop calendar 1	6	0	6
19.03.2014	PM	Morogoro, Kilosa	Ilakala	Miembeny	Crop calendar 2	0	6	6
20.03.2014	AM	Morogoro, Kilosa	Ilakala	Makondeko	Problem tree crop men	0	6	6
20.03.2014	PM	Morogoro, Kilosa	Ilakala	Camp	Livestock calendar: goat	3	3	6
21.03.2014	AM	Morogoro, Kilosa	Ilakala	Makondeko	Problem tree crop women	6	0	6
21.03.2014	PM	Morogoro, Kilosa	Ilakala	Camp	Problem tree livestock men	0	6	6
22.03.2014	AM	Morogoro, Kilosa	Ilakala	mix	Interview: Farmer groups	1	1	2
22.03.2014	PM	Morogoro, Kilosa	Ilakala	mix	Problem tree livestock women	5	0	5
24.03.2014	AM	Morogoro, Kilosa	Ilakala	mix	Interview: farmer older than 65	2	2	4
24.03.2014	PM	Morogoro, Kilosa	Ilakala	mix	Livestock calendar: cattle	2	4	6
25.03.2014	AM	Morogoro, Kilosa	Ilakala	mix	Crop calendar 3	3	3	6
25.03.2014	PM	Morogoro, Kilosa	Ilakala	mix	Crop calendar 4	3	3	6
31.03.2014	PM	Morogoro, Kilosa	Changarawe	mix	Resource map	2	2	4
01.04.2014	AM	Morogoro, Kilosa	Changarawe	Estate	Livelihood Part 1 men	0	6	6
01.04.2014	PM	Morogoro, Kilosa	Changarawe	Estate	Livelihood Part 1 women	6	0	6
02.04.2014	AM	Morogoro, Kilosa	Changarawe	Lyanda	Livelihood Part 2 men	0	6	6
02.04.2014	PM	Morogoro, Kilosa	Changarawe	Lyanda	Livelihood Part 2 women	8	0	8
03.04.2014	AM	Morogoro, Kilosa	Changarawe	Mihogoni	Netmap women	6	0	6
03.04.2014	PM	Morogoro, Kilosa	Changarawe	Dinima	Netmap men	0	6	6
04.04.2014	AM	Morogoro, Kilosa	Changarawe	Lugunga	Problem tree crop women	6	0	6
04.04.2014	PM	Morogoro, Kilosa	Changarawe	Estate	Problem tree crop men	0	6	6
05.04.2014	PM	Morogoro, Kilosa	Changarawe	Mihogoni	Problem tree livestock	3	4	7
07.04.2014	AM	Morogoro, Kilosa	Changarawe	mix	Crop calendar 1	3	3	6
07.04.2014	PM	Morogoro, Kilosa	Changarawe	mix	Crop calendar 2	3	4	7
08.04.2014	AM	Morogoro, Kilosa	Changarawe	mix	Interview: Farmer groups	0	4	4
15.04.2014	PM	Morogoro, Kilosa	Ilakala	mix	Feedback seminar	3	5	8
16.04.2014	AM	Morogoro, Kilosa	Ilakala	mix	Feedback seminar	4	4	8
16.04.2014	PM	Morogoro, Kilosa	Ilakala	Makondeko	Feedback seminar	3	3	6
17.04.2014	AM	Morogoro, Kilosa	Changarawe	mix	Feedback seminar	5	5	10
19.04.2014	AM	Dodoma, Chamwino	Ilolo	mix	Feedback seminar	4	10	14
22.04.2014	AM	Dodoma, Chamwino	Idifu	mix	Feedback seminar	5	5	10
22.04.2014	PM	Dodoma, Chamwino	Idifu	mix	Feedback seminar	5	6	11
Total						224	245	469

2 Pests and diseases as identified by participants

Crop	Description	Cited from
Sesame	<p><i>Pests make clouds on the leaves and they shrink</i></p> <p><i>After planting black spots on leaves when plants are still small</i></p> <p><i>We don't know the name of the insect but it infects the leaves and then the plant gets black, it doesn't dye but it gives a week product, you can find only one grain</i></p> <p><i>Another insect affects the leaves and the plant could not grow, it occurred last year, looks like caterpillar</i></p> <p><i>During flowering</i></p> <p><i>First ones when plant still very low. They affect the leaves. Second ones come when flowering: white insects invade the flower. In January we apply insecticide which will kill them. For the ones in February we do not have an insecticide, the only help is heavy rainfall to swap them away, At the beginning this insects of flowering where not there but after a long drought these insects started to invade the fields and it causes big losses, now it is coming every year</i></p> <p><i>Flowering: They are white, do you know a tick? They look like dust and live under the leaves and move along the stem sucking all the plant fluids till it dries up.</i></p> <p><i>Instead of giving out seeds giving out black hard things</i></p> <p><i>Leaves have many wholes due to insects, when just coming out like a cloud around and plant dries of</i></p> <p><i>Folding of the leaves</i></p>	<p>Problem tree crop men, Idifu, 31.01.2014</p> <p>Problem tree crop women, Ilolo, 18.02.2014</p> <p>Crop calender, Ilolo, 23.01.2014</p> <p>Crop calender, Ilolo, 23.01.2014</p> <p>Problem tree crop women, Ilakala, 21.03.2014</p> <p>Crop calender, Ilakala, 19.03.2014</p> <p>Crop calender, Ilakala, 19.03.2014</p> <p>Problems crop men, Changarawe, 04.04.2014</p> <p>Problem tree crop women, Changarawe, 04.04.2014</p> <p>Crop calender, Changarawe, 07.04.2014</p>
Groundnuts	<p><i>Insects start eating leaves and go downwards</i></p> <p><i>After maturing, larvae is eating up grains</i></p> <p><i>After planting black spots on leaves when plants are still small</i></p> <p><i>Insects like ticks/mite, very small and white, do not destroy completely, if it affects early and the rain comes it washes it away but without rain it gets worse</i></p> <p><i>At the time of flowering, flowers might fall down in big proportion, the groundnuts will have too many insects, leaves are just folding and they do not flower and do not give groundnuts, insect is making it look ready to be harvested and dry but not really ready</i></p>	<p>Problem tree crop women, Idifu, 31.01.2014</p> <p>Problem tree crop women, Ilolo, 18.02.2014</p> <p>Problem tree crop women, Ilolo, 18.02.2014</p> <p>Crop calender, Ilolo, 23.01.2014</p> <p>Problem tree crop women, Changarawe, 04.04.2014</p>
Millet	<p><i>After maturing, larvae is eating up grains</i></p> <p><i>Insects like butterfly (moth)</i></p> <p><i>In millet and sorghum "hombelele" green, like a beetle/fly, Very dangerous insect and can damage the whole plant</i></p> <p><i>Scratch yourself until skin drips of</i></p> <p><i>They attack at night and you just hear their noise but cannot see them</i></p> <p><i>They tried the traditional way of chasing them away but it did not work</i></p> <p><i>Worm which eat the the leaves up to the stem</i></p> <p><i>Storage</i></p>	<p>Problem tree crop women, Ilolo, 18.02.2014</p> <p>Problem tree crop women, Ilolo, 18.02.2014</p> <p>Crop calender, Ilolo, 23.01.2014</p> <p>Crop calender, Idifu, 10.02.2014</p> <p>Crop calender, Idifu, 10.02.2014</p>
Maize	<p><i>Storage</i></p> <p><i>Insects after planting or soon after growing up</i></p> <p><i>There are two types of insects, but "lumwawa" eating the leaves and the corn in early stage, and others are eating the roots</i></p> <p><i>Yellow leaves</i></p> <p><i>Plant turns yellow and sometimes does not give any output at all, occurs mostly on the slopy area (yellow, and stunting)</i></p>	<p>Problem tree crop men, Ilakala, 20.03.2014 ; Crop calender, Ilakala, 19.03.2014</p> <p>Problem tree crop women, Ilakala, 21.03.2014</p> <p>Crop calender, Ilakala, 19.03.2014</p> <p>Problem tree crop men, Changarawe, 04.04.2014</p> <p>Problem tree crop women, Changarawe, 04.04.2014</p>

Pearl millet	<i>The one which is early maturing is good but the one which is late maturing gets pests like larvae</i>	Crop calendar, Idifu, 11.02.2014
Rice	<i>Maturing of the rice: pests eat all fluids before further maturing</i> <i>During nursery there are insects in the soil which destroy the plants or inhibit their germination</i> <i>Disease in rice called "Kiuengu", changes color of leaves into yellow, then they dry and no rice corn can be found</i> <i>Yellow leaves: It's a chronic disease from long time ago, it keeps moving, if it reaches the plant in the moment when the seeds are developing you won't get anything, it is occurring in the bottom part where they cultivate rice, if there was good rain and then it stops like 1,5 months then it is accelerating the disease</i> <i>Seeds might not have the brown color it is supposed to have but a white one</i>	Problem tree crop men, Idifu, 31.01.2014 Crop calendar, Idifu, 10.02.2014 Problem tree crop men, Changarawe, 04.04.2014 Problem tree crop men, Changarawe, 04.04.2014 Problem tree crop women, Changarawe, 04.04.2014
Sunflower	<i>It grows, but when it reaches a certain stage the leaves start folding and it does not give good produce, when flowering, white insects all around even if big flower nothing inside</i> <i>Seeds for the oil might shrink and do not give out oil</i>	Problem tree crop women, Changarawe, 04.04.2014 Problem tree crop women, Changarawe, 04.04.2014
Bambara nuts	<i>After planting black spots on the leaves when plants are still small</i> <i>Worms inside of the soil eating the roots and the plant starts drying</i> <i>Crops that insects like more</i> <i>"mbulumundu" like grass hopper destroy bambara nuts</i> <i>When it grows there are some insects eating the stem and at the end it dries of, insect at the roots and plant dries of</i>	Problem tree crop women, Ilolo, 18.02.2014 Crop calendar, Idifu, 11.02.2014 Problem tree crop women, Ilakala, 21.03.2014 Problem tree crop men, Changarawe, 04.04.2014 Problem tree crop women, Changarawe, 04.04.2014
Pigeon Pea	<i>Insects like flies and others; plant dries of or does not give good peas</i> <i>Pest that make holes into the seeds: It is a big problem because you cannot use them for seeds anymore, all years they just destroy the seeds</i> <i>There is a certain lice special in pigeon pea disturbing them, they are applying pesticides but they are not sure of the pesticides they are using, that is a very big problem, because you find the lice and once they invade in the pigeon pea they invade the leaves and the stem, the leaves dry and you find something like honey inside the leaves, at the end the pigeon pea is not growing anymore and has many insects, pesticides often do not work</i> <i>Another insect (participants don't know the name) that arrives when the plants starts to put the seeds into the hull, when it inserts its mouth in there you will see the hull is no longer good, it folds itself and it is destroyed, very small insect with a sharp mouth and black, in both seasons, all plots are the</i> <i>Another insect after the pigeon pea is out it makes just small holes into the leaves, it is black at the back and brown at the stomach and flying</i>	Problem tree crop women, Changarawe, 04.04.2014 Crop calendar, Ilakala, 25.03.2015 Crop calendar, Ilakala, 25.03.2015 Crop calendar, Ilakala, 25.03.2015 Crop calendar, Ilakala, 25.03.2015
Cassava	<i>Whitish stuff on the leaves, like a cloud, sometimes then only the roots without cassava and if you find cassava it tastes bitter</i> <i>"Mbulumundu" like a grass hopper, eat the stem and the leaves, even if you harvest the cassava it gets very bitter, from October, if it rains very heavy they will die, otherwise they become very big and stay until March</i> <i>Other insects like small worms</i>	Problem tree crop women, Changarawe, 04.04.2014 Crop calendar, Ilakala, 19.03.2014 Crop calendar, Ilakala, 19.03.2014
Tomato	<i>Fungal disease: leaves shrink and get white leaves, Fruits are black inside</i> <i>yellow leaves</i>	Problem tree crop men, Idifu, 31.01.2014 Problem tree crop men, Ilolo, 18.02.2014
Grapes	<i>Quality effects of pests</i>	Problem tree crop men, Ilolo, 18.02.2014
Beans	<i>When harvested the hull is there but inside the hull there is nothing</i>	Problem tree crop women, Changarawe, 04.04.2014

Statutory declaration

I herewith declare that I composed my thesis submitted independently without having used any other sources or means than stated therein.

Date

Signature