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Participatory problem analysis of crop production in the case study sites: preliminary report

Extract from Maria Höhne's MSc draft thesis: "A participatory situation analysis of Tanzanian smallholder farming systems: identifying points of entry for innovation from the farmer's perspective"

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Extract from Maria Höhne's draft MSc thesis of: "A participatory situation analysis of Tanzanian smallholder farming systems: identifying points of entry for innovation from the farmer's perspective"

This extract presents information on farmer perceptions of problems prevalent in crop production in all four CSS.

1 Methods

Field data collection was carried out from January until April 2014 in four representative case study sites (CSS) in the Morogoro (semi-humid) and Dodoma (semi-arid) regions of Tanzania. The data collection aims to represent the farmers' points of view. The study aims to identify potential points of entry for innovations by analyzing constraints and opportunities, while recognizing available capitals (natural, physical, economic, human, social) and responding to commonly held livelihood problems and shared challenges in agricultural production processes. As such, a participatory problem analysis formed a part of this work.

In order to get an insight into village people's perception, interrelations and priorities on problems in crop farming, participatory group discussions were conducted as well as some semi-structured interviews with key informants. 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.[1]

1.1 Communication tools

For participatory group discussions, participants were selected by a local contact person. Except for Ilolo, 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. Together with the local contact person, morning and afternoon sessions were organized in agreement with the participants. Each session took around two hours. In all sub villages on-site discussions were conducted. Although there was a planned number of participants defined beforehand, often more people than expected joined the discussion. Everyone was free to attend and get involved into the discussion.

For the livelihood analysis, net map and problem tree tools, the groups were segregated by gender. Resource maps and seasonal calendars were developed in mixed groups. With the agreement of participants, group sessions were recorded with an audio recorder; notes were

[1] Work in the two regions was supported by different translators.

also taken. Posters with tables or graphs and calendars were developed together with participants during the sessions. Photographs were taken of all the posters. In Table 1, an overview of conducted group discussions (including the number of sessions and participants for each village) is given.

Table 1 Overview of communication tools

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

Information presented in this extract draws mainly from the seasonal calendars and problem trees. These were selected because of the high quantity of information obtained around problems in crop production[2]. These tools are outlined below.

Seasonal calendar

The seasonal calendars were developed during two sessions in Idifu, one session in Ilolo, four sessions in Ilakala and two sessions in Changarawe. For the seasonal calendar mixed groups of 3 women and 3 men were brought together. Because most farming activities are conducted together by men and women, this seemed to be appropriate. An empty calendar 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. The information given on rainfall and weather events differed a

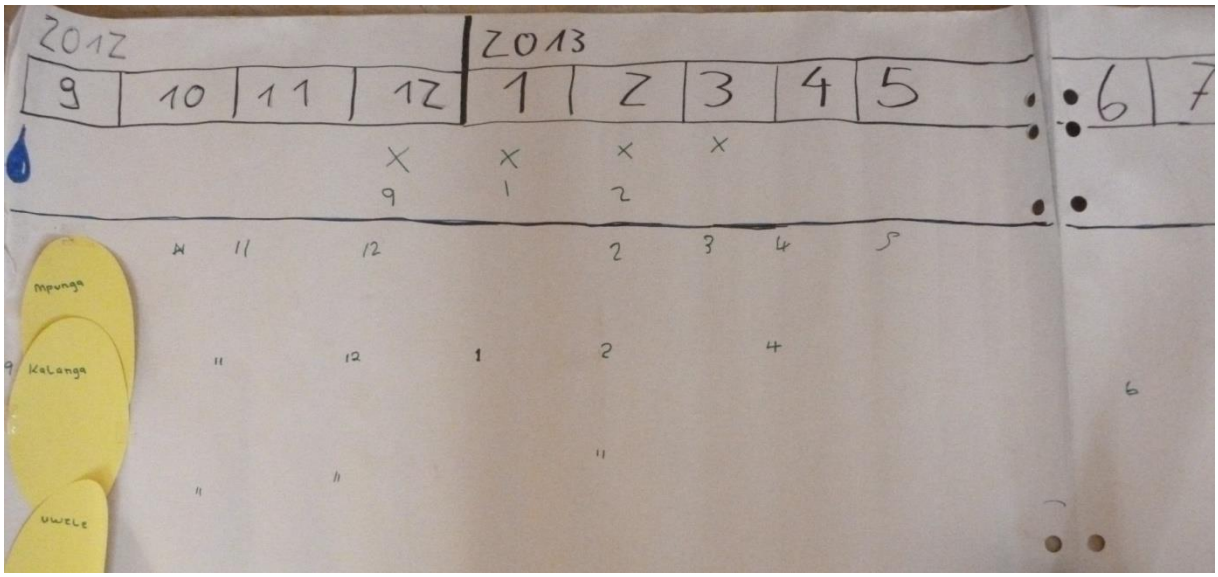
[2] This extract was originally prepared in order to inform the UPS mission in July, therefore presenting information on problem perceptions of farmers and relevant entry points for UPS was prioritized.

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 by participants. Due to time constraints, the participants then had to select the most important ones (from their perspective), 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 activities.

The tool provided information about activities and how things are managed for specific crops. We looked at divisions of labor and pointed out the differences in farming between different crops. The tool also worked to identify problems at different stages of production.

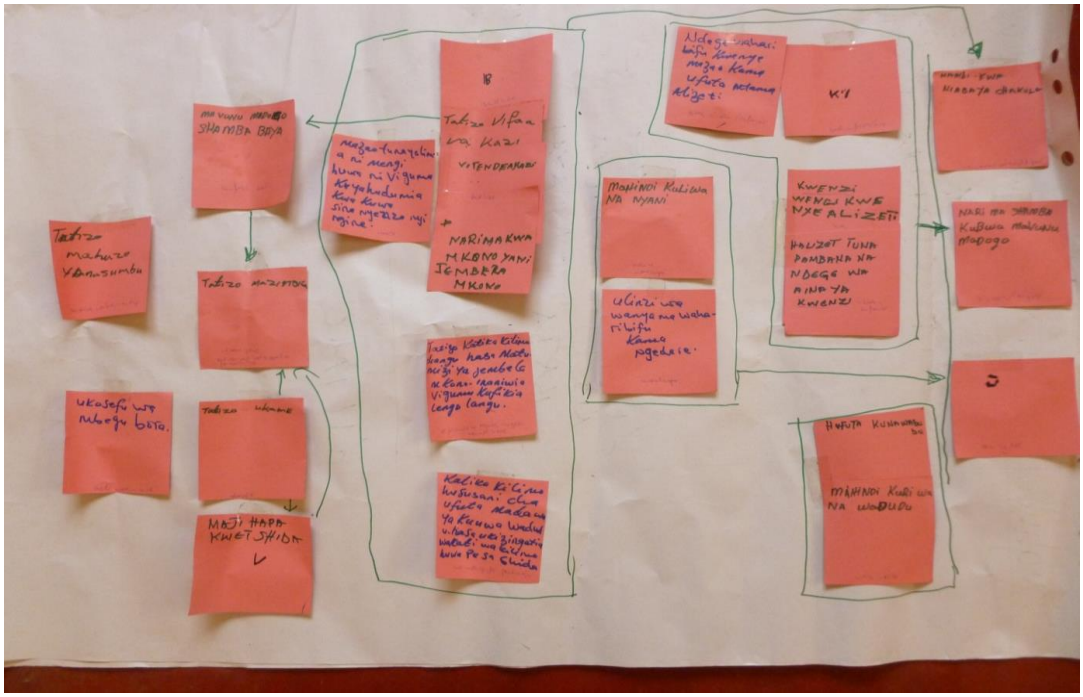
In Picture 1, an example of a seasonal calendar in Idifu can be seen.



Picture 1. Crop calendar: Idifu

Problem tree

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 their own problems on a piece of paper. Problems were often mentioned several times by different participants, thereby indicating the relevance or importance of the problem. When all problems were collected, they were sorted by topic by the moderator and then discussed further. The discussion included a detailed explanation of the problem and attempted to identify possible connections with other problems, highlighting 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 interlinkages on a poster. In Picture 2 an example of a problem tree developed by men in Ilakala can be seen.



Picture 2 Problem tree crop: men, Ilakala

1.2 Feedback seminars

After the data collection was accomplished and a preliminary data analysis conducted, feedback seminars lasting around 2.5 hours were organized in all CSS, to report back to participants. Feedback seminars started by giving information about why the research was conducted, for whom and for what purpose this information has been collected. Topics discussed included resources and assets, livelihood, and a discussion about the strengths, weaknesses, opportunities and threats in each village. The topics were presented on posters and participants were encouraged to contribute to the posters. After every introduction to a topic, a critical discussion with the participants took place. All sessions were recorded.

Table 2. Overview of feedback seminars

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

1.3 Data analysis

For this preliminary problem analysis of crop farming, information from the participatory problem trees and seasonal calendars was analyzed. Audio data and visual data was summarized and transferred into tables. Complete translations and transcriptions of audio data were only done for single sessions which contained much untranslated discussion. For all other sessions the English sections of the audio recording were transcribed or paraphrased. The entire text produced was then categorized and coded using the software RQDA.

2 Results

2.1 Agricultural activities

2.1.1 Crop production

The seasonal calendars revealed some common aspects and activities for all crops farmed. It was shown that crop production is the most important livelihood activity across all CSS. Farming activities are conducted by the inner family (usually meaning a woman and/or man, supported to a certain extent by children). Children from the age of 10 are introduced to farming activities and help their parents on weekends and holidays. The participants reported that men and women are involved almost equally in the work, with most activities conducted together excepting small differentiations that are listed in Table 4. In general, women are more engaged with food crops while men are well informed about cash crops and related trade issues.

Table 3 Crop farming activities as indicated by men and women

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	Weeding	*"Men use the ox hoe while women are supposed to do weeding using hand hoe."*	Dododma	Ilolo, women; Idifu, women
m	Pesticides	Buying and apllication of pesticide	All	Livelihood 1 women, Ilakala, 15.03.2014
w	Tools	Do not own oxen, other animals or a bicycle	Dododma	Net map women, Ilolo, 19.02.2014
m	Rice	Preparatipon of rice nursery	Idifu	Crop calender, Idifu, 10.02.2014
m	Rice	*"For rice crops men are engaged more than women, because it is hard work"*	Idifu	Problem tree crop men, Idifu, 31.01.2014
w/m	Rice	*"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."*	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: "*men do it because women cannot do it streight*"	All	Crop calender, Changarawe, 07.04.2014
w	Maize	Harvesting: "*If you have a large area to harvest men would rather employ other people to help them, then harvesting themselves*"	Morogoro	Crop calender, Ilakala, 19.03.2014 ; Crop calender, Changarawe, 07.04.2014
m	Maize	Transport of harvest home by bycicle	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	Simsim	Prefered by men	Morogoro	Livelihood 1 women, Ilakala, 15.03.2014
m	Simsim	Application of pesticides	All	Crop calender, Ilakala, 19.03.2014; Problem tree crop women, Ilakala, 21.03.2014
w	Simsim	Cleaining the simsim at the field	Morogoro	Crop calender, Changarawe, 07.04.2014
m	Millet	Threshing	Dododma	Crop calender, Idifu, 10.02.2014
w	Millet	Removing residuals	Dododma	Crop calender, Idifu, 10.02.2014
w	Bambara nuts			
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

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	*"My son is the one make follow up.He went to the extension officer who gave him a medicine. He came back home and we it to the chicken and they recovered."*	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

Crops differ among the CSS according to their 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.

Land preparation is in most cases mainly done by hand hoe. 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. Their rent would be more expensive than the rent of a tractor. 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, Ilolo, 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).

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, Ilolo, 23.01.2014). Most 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. The majority of the participants reported using only local seeds, which are stored by the farmers for the next season. If a new beneficial variety was introduced to the

village, neighbors also buy seeds from each other, because seeds will be cheaper than buying them in town.

> *"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, man).*

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 simsim and bambara nuts.

Weeding is a very time consuming activity exclusively done by hand hoe in all CSS. Most of the crops demand two weeding sessions. With rice, weeding even has to take place by hand.

Although most crops are rainfed, the vegetable fields are additionally irrigated during grow out of the crops. In Dodoma 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.

The harvest also takes place by hand. Depending on the crop, people either pick by hand or use equipment such as bush knifes. 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.

Food crops such as maize or millet are stored as food and seed for the upcoming season. The harvest is most often stored in either polyethylene bags or plastic buckets. 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). If excess was produced, it can and will be sold. The cash crop simsim will be completely sold; only a part is kept as seeds for the next year. Since none of the CSS have a central market site, the harvest is sold to small local traders who are passing through, usually during the harvest time.

Traders usually have fixed prices which cannot be bargained. Men are the ones who organize the trade and receive the money.

2.1.2 Details on selected crops: results of the seasonal calendar

Different crops are produced across the four CSS. The following tables draw from information generated by the seasonal calendar tool to highlight different crop activities, uses and problems from farmer perspectives.

Table 4 Crops listed in group discussion per village

Dodoma			**Morogoro**		
Idifu	**Ilolo**	characteristic aspects	**Ilakala**	**Changarawe**	characteristic aspects
Bullrush millet	Bullrush millet	food crop, drought resistent	Maize	Maize	main food crop, intercropped with pigeon pea/ pumpkin
Groundnut	Groundnut	cash crop, less drought resistent than Millet, intercropped with Millet	Simsim	Simsim	main cash crop, pesticide demand
Sunflower	Sunflower	processed in Mvumi	Bulrush millet	Bullrush millet	
Maize	Maize	mainly in home gardens, smaler portions, drought reluctant	Pigeon pea	Pigeon pea	intercropped with cotton or maize
Bambara nuts	Bambara nuts	small portions because no market	Cow pea	Cow pea	
Pale millet		not as drought resistent as pearl millet but higher yields	Bambara nuts	Bambara nuts	intercropped with simsim
Rice		young men, new crop, hard work, risky, tractor	Cotton		cotton board for marketing
Cow pea	Cow pea	Intercropped with millet/maize	Sunflower	Sunflower	processed in Kilosa or Mikumi
Vegetables: esp. tomatos	Vegetables	young farmer, more risky in terms of pest and diseases, capital for inputs	Rice	Rice	small paddies, women
Simsim			Groundnuts	Groundnuts	women
	Grapes	high input demand, difficulties in trading	Cassava	Cassava	breakdown as cash crop after introduction of simsim, drought resistent, intercropped with Maize/Simsim
	Sugarcane		Sweet potatoe Bananas Sorgum Tobacco	Sweet potatoe	
			Beans	Beans Vegetables Sugarcane	

Crops listed in Table 4 were mentioned throughout the sessions. The first two crops under each village are the ones that were always grown by every family. In Dodoma, millet was the most important food crop and groundnuts the most important cash crop. In Morogoro it is maize as the most important food crop and simsim as most important cash crop. Aspects that make crops different from each other are listed in the last column. The points listed here already give an insight into where possible problems could arise. In relation to the priority UPS crops, for maize, there is always the danger of drought. Simsim is an important cash crop that has a high demand for pesticides and with sunflower, the biggest issue is where to process it.

In Table 5 the farming calendars for bulrush millet, simsim and groundnut in Ilolo are presented for the farming season 2012/2013. In Table 6 the farming calendars for rice, groundnut, bulrush millet, sunflower, pale millet and bambara nuts in Idifu are presented for the farming season 2012/2013. In Table 7 the farming calendars for cassava, maize, simsim,

pigeon pea and cotton in Ilakala are presented for the farming season 2012/2013. In Table 8 the farming calendars for maize and simsim in Changarawe are presented for the farming season 2012/2013. 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. The information given on rainfall and weather events differed a lot between sessions. However, this does not necessarily mean that the information is inaccurate, as it was reported that rainfall differs a lot between sub villages.

In all CSS, the heavy effects of drought can be realized by looking at the yield results. 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 simsim in Changarawe.

Table 5 Ilolo, Dodoma, Seasonal calendar: Bulrush millet, simsim, 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
SIMSIM	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 women: removing residuals	drying, storage				none-average	drought

Table 6 Idifu, Dodoma, Seasonal calendar: Groundnut, Millet, Sunflower, Pale 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 men/women only	preparation of the field			tilling and seeding	tilling and seeding	weeding	growing	growing	growing	harvest, threshing and separation threshing (m), removing residual (w)	storage	average	
						very cold							
rainfall			17th	x	x	x	x	x					
SUNFLOWER		preparation of the field				tilling & seeding	weeding		harvest			bad	drought
PALE 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 7 Ilakala, Morogoro, Seasonal calendar: cassva, maize, simsim, 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					
SIMSIM	field preparation		seeding	1.weeding and reducing of some plants	2. weeding and application of pesticides		havest, 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		not that good	

Table 8 Changarawe, Morogoro, Seasonal calendar: maize, simsim

	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				
SIMSIM		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

2.2 Key constraints: rainfall, labor and capital

According to the information obtained from the participants in all CSS, there are three main limitations to the agricultural activities that create the framework of the farming system. Firstly, as the crop farming systems are in general rainfed low external input systems, the farming activity schedule is shaped mainly by the local climate. Hence climate is the first major limiting factor in the CSS. 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 6, 7, 8 and 9.

There are three points that regularly interrupt this ideal farming schedule. These are: a trade-off of using time for farming versus using time for other important activities; the dependency on others for equipment and inputs, and; unexpected environmental events. Detailed results for these points will be given below according to the different farming steps.

The second limitation to highlight is labor availability. In this context, labor is the major resource required to create an agricultural output. In an "ideal" or typical family, two people are working on a farm: husband and wife. Older children can be an additional source of labor. What can be realized on the farm depends a lot on this household work force and how much can be done in a given time. Accordingly, the depth of problems in agriculture differs depending on socio demographic attributes (age, gender, education) of the household members. Older farmers in particular reported that life is becoming increasingly hard since their children are often not able to support them:

> *"In former years I was even assisting my father but now my son has a family and the family is depending on him, but he has no high income neither and the children need to go to school. The son would wish to help me but he can't because of the responsibility for his own family." (Problem tree crop, Changarawe, 04.04.2014, Man)*

Women in all CSS also complained a lot about the hard work related to agriculture and its effects. Especially affected are single female households that lack the additional labor in the field:

> *"Men use the ox hoe while women are supposed to do weeding using hand hoe, it is hard work." (Problem tree crop, Ilolo, 18.02.2014, Woman)*

> *"When we come back from the farm we will 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 the fire wood and the hand hoe" (Problem tree crop, Idifu, 31.01.2014, Woman)

"Farming is disturbing me. We get sick during farming. Sometimes I cannot turn my neck or we get Malaria or stomach ache. We don't eat properly during crop cultivation because we don't have enough food in the house" (Problem tree crop, Ilakala, 21.03.2014)

Thirdly, capital is a major constraint to crop production activities. Financial resources are needed to facilitate certain productivity-enhancing activities such as using inputs or advanced equipment. The lack of immediate capital available is especially limiting as people are unable to intervene in the moment of need. On the one hand, the lack of capital is a result of having no long-term cash savings tradition in the households. To a larger extent, it is a result of the increasingly changing natural and economic environment. Ultimately, this is a chronic, ongoing problem with long term effects.

Agriculture is the major source of food and income, generating both only on a time-specific seasonal scale, which means that there is only a limited period for 'investing' up to the next harvest. Following discussion with local people, one such example of the "worst case scenario" 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 casual 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.'

So the lack of capital for development is becoming a vicious circle that is hard to escape from.

If people have limits in available capital, they will have to make economic decisions weighing opportunity costs of how to invest resources most beneficially. Since a lot of labor is generally needed for agricultural activities, there is only a little time left to do basic additional activities. Such activities are either related to what people do and know anyway, meaning farming or cooking for example, or which may be small temporary or piece jobs. In order to start other activities, people would not only need time and starting capital, but also more diversified knowledge. However, sources of education are rare, which is especially affecting the younger generation and resulting in less diversified perspectives for the future. As a farmer in Ilolo said:

> "From the day you are born you find your parents being farmers and you know nothing else than agriculture." *(Problem tree crop, Ilolo, 18.02.2014*)

Another reason is that "people live with history in their mind" (Problem tree crop men, Ilolo, 18.02.2014). Gossip is a strong source of information and if "the neighbor of the neighbor of the neighbor from another village" failed in doing another activity, people hesitate to try the unknown, as the same man in Ilolo commented. Issues related to the lack of capital will be explained in the next subitem.

Important to mention is that in all CSS, problems and their depth may differ a lot on the sub village level because all the 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 water, especially during the dry season. This time is then unavailable for other (food/income generating) activities:

> *"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 water 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, Man)*

Another such situation can be found between Changarawe and the sub village Lugunga, which is also situated far away from village infrastructure and less connected to the center. While the rest of the village is fairly well developed, especially benefiting from electricity along the main road, Lugunga remains less developed. Women reported that:

> *"Women in the sub village have no other option to earn some money apart of farming, not even making mandazi[3] or chapatti. Sometimes we try but it is hard because nobody will buy them. Sometimes we prepare mandazi of 1kg but we remain with them for 3 days." (Problem tree crop, Changarawe, 04.04.2014)*

2.3 Specific problems in crop production

2.3.1 Land preparation

In Changarawe in particular, participants complained about the availability of fertile land for farming. The village has limited fertile sandy soil. People from the central sub villages--Estate, Madisini and Lyanda-- were given two acres of fertile land from the former sisal estate company. Nevertheless, two acres per household are not a lot and so people also rent from one another. The land around the river is highly appreciated for lucrative vegetable cultivation and can be rented.

[3] Mandazi: popular raises pastries fried in oil

However, according to the farmers, the problem is not simply that the land is not enough, but also that it is not secured. People were asked only to plant annual crops because the land owner may come back at any time. This had happened in 2013 in the sub village Lugunga, where the official land owner decided to farm on his land, which had traditionally been used by sub village inhabitants without official land title. Therefore, Lugunga inhabitants are now forced to a large extent to rent land. In order to afford that money, people commented that they have to sell the bigger part of their harvest (Problem tree crops women, Changarawe, 04.04.2014). According to the participants, prices for rent had increased significantly from about 20 000Tsh/acre in 2013 to between 30 000Tsh and 40 000Tsh/acre in 2014 (Problem tree crops women, Changarawe, 04.04.2014). This dependency on renting land is also occurring due to the fact that Changarawe, as well as Ilakala, are villages where a lot of immigration has taken and is still taking place, hence less people can inherit land from parents for free in the village because their parents are not from the area. People therefore must independently seek land.

Fertile land is also scarce in Dodoma. Most particularly in Ilolo, farmers were reporting a scarcity of land in the very fertile swamp area. It is possible to rent land there, but prices are high and people usually own or rent less than one acre (Problem tree crop men, Ilolo, 18.02.2014).

Ultimately, obtaining land needs capital; land preparation may need capital as well. So before even starting the preparation of the field, people might be preoccupied by doing casual labor for others in order to be able to afford the rent for land or an ox or tractor, or simply food for the family:

> *"During farm preparation you may find that some people don't have food, so instead of farm preparation they go to search for food and after they do the land preparation but as a result they plant late in the season." (Problem tree crop, Ilolo, 18.02.2014, Man)*

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

> *"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, Man)*

Due to financial and time limitations, land preparation in most cases is still done using a hand hoe. According to the participants, this creates problems with yield and limits cultivation to small portions of land.

> *"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, Woman)*

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 pasture their cattle and small ruminants on other people's farms after harvest. The major problem here is that the soil is getting very hard from compaction:

> *"The cattle are passing on the field during dry season and after harvest. Now the problem is that they make the land very hard. They cause 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, Man)*

> *"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 then loss but nothing was paid up to now and no 100 000Tsh would cover the loss." (Crop calendar, Changarawe, 07.04.2014, Person)*

As described in Changarawe, in few cases the cattle are even entering before harvest, which can be a disaster for the whole harvest. There are as yet no useful regulations to solve this conflict. For example, in Changarawe one farmer also reported:

> "Even if you blame one 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)

2.3.2 Seeding

Participants were often complaining that only local seeds are available or accessible to them. Quality attributes identified as important to them were: early maturation, high produce and drought resistance. Even if new seeds were introduced to the village, participants recognized that their output became less favorable over time. They reported that they sometimes could only afford a small portion of quality seeds, 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 simsim. Participants justified the selection in the following terms:

> *"Especially Maize because if it would get a higher yield the problem of food shortage would be solved, especially simsim because it 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, Man)*

Immediately after seeding, rodents and birds create a problem because they eat up the seeds. Birds are chased away but rodents cannot be seen:

> *"Rodents are the first ones eating the seeds. Better the birds than the rodents because rodents come at night." (Problem tree crop, Ilakala, 21.03.2014, Man)*

2.3.3 Weeding

Almost all participants reported that weeding is a very exhausting and time consuming activity. This was especially the case for women, who reported that the period of weeding is 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 secondary weeding.

> *"You may cultivate using the ox hoe-- for example each one of us is using the ox hoe-- but we fail in weeding. It means even if you have an ox hoe, you cannot use it for weeding." (Problem tree crop, Ilolo, 18.02.2014, Man)*

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.

As with the land preparation, 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. 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.

Weeds are especially a problem with rice cultivation. 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.

2.3.4 Grow out

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 were several years of drought in a row. People referred to two major effects of this: firstly, it of course directly affects the crops, making them dry and leading to low or no output at all, as reported for the last year (compare seasonal calendars). One of the most important staples in Morogoro--maize-- is especially affected by drought situations, as one of the most important cash crops in Dodoma --groundnut. Secondly, another major effect of recurrent drought is that farmers become insecure in scheduling their farming activities. They report that for their foreparents, 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 and respond to risk.

> *"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, Man)*

It is a situation in which 'traditional' knowledge is not offering solutions to the challenges of these times.

If the drought did not already lead to the crop failure through water stress, the next big problem is created by pests and diseases. These occur on different levels during the development of the crops. Most often the only solution perceived by participants was to hope that the rain would come to wash away insects. Only in simsim production were pesticides always applied, because participants reported that otherwise almost nothing

could be harvested. The dependency on pesticides when growing simsim can be seen as a problem as such, in the least because it increases the capital requirements of the household to buy pesticides and to rent the applicator.

Nevertheless, in simsim, and also with other plants, participants reported on a rather new pest infestation during flowering, 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." (Crop calendar, Ilakala, 19.03.2014, Person)*

In other cases, if insects overwhelm the fields early in the season, there is still the option to replant, but as mentioned, 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 were able to buy pesticides. In Table 9, a collection of pest 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.

Table 9 Pests and Diseases as observed by farmers

Crop	Description	Cited from
Simsim	*Pests make clouds on the leaves and they shrink*	Problem tree crop men, Idifu, 31.01.2014
	After planting black spots on leaves when plants are still small	Problem tree crop women, Ilolo, 18.02.2014
	They 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	Crop calender, Ilolo, 23.01.2014
	Another insect affects the leaves and the plant could not grow, it occurred last year, looks like caterpillar	Crop calender, Ilolo, 23.01.2014
	During flowering	Problem tree crop women, Ilakala, 21.03.2014
	First ones when plant still very low they affect the leaves, second ones come when flowering: white insects invade the flower, In January they apply insecticide which will kill them, for the ones in February they 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	Crop calender, Ilakala, 19.03.2014
	Flowering: Like a certain white dust or larvae, do not stay on top of the leaves but under the leaves, are eating the stem until it dries	Crop calender, Ilakala, 19.03.2014
	Leaves have many wholes due to insects, when just coming out like a cloud around and plant dries of	Problem tree crop women, Changarawe, 04.04.2014
	Folding of the leaves	Crop calender, Changarawe, 07.04.2014
Groundnuts	*Insects start eating leaves and go downwards*	Problem tree crop women, Idifu, 31.01.2014
	After maturing, larvae is eating up grains	Problem tree crop women, Ilolo, 18.02.2014
	After planting black spots on leaves when plants are still small	Problem tree crop women, Ilolo, 18.02.2014
	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	Crop calender, Ilolo, 23.01.2014
	At the time of flowering, flowers might fall down in big proportion, the groundnuts will have too many insects, leave are just folding and they do not flower and do not give groundnuts, insect making it look ready to be harvested and dry but not really ready	Problem tree crop women, Changarawe, 04.04.2014
Millet	*After maturing, larvae is eating up grains*	Problem tree crop women, Ilolo, 18.02.2014
	Insects like butterfly (moth)	Problem tree crop women, Ilolo, 18.02.2014
	In millet and sorghum "hombelele" green, like a beetle/fly	Crop calender, Ilolo, 23.01.2014
	Worm which eat the the leaves up to the stem	Crop calender, Idifu, 10.02.2014
	Storage	Crop calender, Idifu, 10.02.2014
Maize	*Storage*	Problem tree crop men, Ilakala, 20.03.2014 ; Crop calender, Ilakala, 19.03.2014
	Insects after planting or soon after growing up	Problem tree crop women, Ilakala, 21.03.2014
	There are two types of insects, but "lumwawa" eating the leaves and the corn in early stage, and others are eating the roots	Crop calender, Ilakala, 19.03.2014
	Yellow leaves	Problem tree crop men, Changarawe, 04.04.2014
	Plant turns yellow and sometimes does not give any output at all, occurs mostly on the sloppy area (yellow, and stunting)	Problem tree crop women, Changarawe, 04.04.2014
Pale millet	*The one which is early maturing is good but the one which is late maturing gets pests like larvae*	Crop calender, Idifu, 11.02.2014

Rice	*Maturing of the rice: pests eat all fluids before further maturing*	Problem tree crop men, Idifu, 31.01.2014
	During nursery there are insects in the soil which destroy the plants or inhibit their germination	Crop calender, Idifu, 10.02.2014
	Disease in rice called "Kiuengu", changes color of leaves into yellow, then they dry and no rice corn can be found	Problem tree crop men, Changarawe, 04.04.2014
	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	Problem tree crop men, Changarawe, 04.04.2014
	Seeds might not have the brown color it is supposed to have but a white one	Problem tree crop women, Changarawe, 04.04.2014
Sunflower	*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*	Problem tree crop women, Changarawe, 04.04.2014
	Seeds for the oil might shrink and do not give out oil	Problem tree crop women, Changarawe, 04.04.2014
Bambara nuts	*After planting black spots on leaves when plants are still small*	Problem tree crop women, Ilolo, 18.02.2014
	Worms inside of the soil eating the roots and the plant starts drying	Crop calender, Idifu, 11.02.2014
	Crops that insects like more	Problem tree crop women, Ilakala, 21.03.2014
	"mbulumundu" like grass hopper destroy bambara nuts	Problem tree crop men, Changarawe, 04.04.2014
	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	Problem tree crop women, Changarawe, 04.04.2014
Pigeon Pea	*Insects like flies and others; plant dries of or does not give good peas*	Problem tree crop women, Changarawe, 04.04.2014
	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	Crop calender, Ilakala, 25.03.2015
	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	Crop calender, Ilakala, 25.03.2015
	Another insect (they 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 same	Crop calender, Ilakala, 25.03.2015
	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	Crop calender, Ilakala, 25.03.2015
Cassava	*Whitish stuff on the leaves, like a cloud , sometimes then only the roots without cassava and if you find cassava it tastes bitter*	Problem tree crop women, Changarawe, 04.04.2014
	"Mbulumundu" like a grass hopper, eat the sting and the leaves, even if you harvest the cassava gets very bitter, from October, if it rains very heavy they will die, otherwise they become very big and stay until March	Crop calender, Ilakala, 19.03.2014
	Other insects like small worms	Crop calender, Ilakala, 19.03.2014
Tomato	*Fungal disease: leaves shrink and get white leaves, Fruits are black inside*	Problem tree crop men, Idifu, 31.01.2014
	yellow leaves	Problem tree crop men, Ilolo, 18.02.2014
Grapes	*Quality effects of pests*	Problem tree crop men, Ilolo, 18.02.2014
Beans	*When harvested the hull is there but inside the hull there is nothing*	Problem tree crop women, Changarawe, 04.04.2014

Farmers not only complained about the availability of fertile land, but also about soil fertility in general, which is thought to affect their output. Many reported that fertility is strongly related to preparing land only by hand hoe, because the fertile part of the soil would stay down and would not be reachable for the crops. In Morogoro, farmers are not familiar with the application of animal manure to increase soil fertility. 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, 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:

> *"Usually with manure you harvest more. But last year those who put manure even harvested less." (2013 year of drought) (Problem tree, Ilolo, 18.02.2014, Ilolo)*

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. And on that tunnel when you grow any crop it will grow 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 left overs 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)*

In Changarawe a farmer recognized the value of intercropping:

> *"I am mixing with pumpkin but do not cut the big pumpkin leaves. Like that I only have to weed once because the leaves prevent the weeds to come out fast."(Crop calendar, Changarawe, 07.04.2014)*

Particularly in Ilakala and Changarawe, participants mentioned the effects of farming on slopes. While the bottom parts are very fertile, (accordingly also more expensive in rent or acquisition), 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:

> *"When it rains the fertile part is taken down. We tried to terraces 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, Man)*

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 swamp 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.

> *"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, Man)*

Although no active agriculture steps are necessary after weeding and during grow out, according to the farmers, there is still a lot of time needed just to take care of fields and chase away the animals.

In many discussions, irrigation was a pertinent topic. In the swamp areas of the two CSS in Dodoma, people irrigate their vegetable farms often by hand bucket. 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:

> *"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, Man)*

2.3.5 Harvest

Reported problems in harvesting were rather related to issues of transport and were more important in Dodoma than in Morogoro. Within Dodoma, such issues were more important in Idifu than in Ilolo. Of all CSS, people in Idifu are the poorest, in that very few people can afford a bicycle or an ox cart for transport. In general, ox carts are more popular to transport harvest in Dodoma. Most people have to rent, which incurs costs and also requires time to spend waiting for the cart to become available. Part of the harvest always has to be transported home by feet.

2.3.6 Storage

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. Most people later on store the produce in

polyethylene bags, although they are unsatisfied with this way of storage because insects and rodents can enter into the bags and destroy the seeds. However, traditional storage containers are not very common anymore.

2.3.7 Processing

Processing facilities are an issue for farmers. All CSS had only a milling machine at their disposal. Especially for oil seeds, such as sunflower, it is a problem because the next processing entity is far away and therefore means that transportation needs to be paid for. For all CSS the next processing entity was in the nearest bigger town and served all surrounding villages. This means that people not only need money but also time to finally process their seeds.

"There is no processing machine up to Mvumi. Last year I have harvested 4 bags but how to come from my sub village to Mvumi and in Mvumi there is only one processing machine but like 35 villages have to use it" (about sunflower)(Problem tree crop, Idifu, 31.01.2014, Man)

It seems uncommon for people to regularly help each other, for example to organize the processing in groups. There seems to be a lack of trust among village people:

> *"You don't let other people bring the seeds for you. The person is not trustworthy. At the end of the day he might tell you 'Oh, I got some problems.' and he wants extra money for transportation." (Problem tree crop, Ilakala, 21.03.2014, Man)*

2.3.8 Marketing

Overall, market demand is defining which cash crops are grown. None of the CSS has a reachable fixed market where products could be traded. 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.

> *"What he means is, there is a market but very far, therefore transportation cost 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) will incur more costs. So the market is very far from the producers." (Problem tree crop, Ilolo, 18.02.2014, Man)*

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

> *"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, Ilolo, 18.02.2014, Man)*

Few people are able to store for longer and wait until prices increase again.

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 aspect renders people even more vulnerable to the behavior of local traders.

Against common thinking that a drought would increase prices for the harvest in Ilolo, for example, 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 come to the village, only a few bother and they have an even better position for determining the prices (Problem tree crop women, Ilolo, 18.02.2014).

Additionally, the world market price volatility of the last years also had effects on the CSS. People are increasingly insecure of which income they can expect from their harvest. Participants reported that prices differ a lot on seasonal and yearly basis.

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 has a monopolistic position (Crop calendar, Ilakala, 25.03.2014).

Also for simsim, 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. They therefore 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).

For cotton and simsim 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).

2.3.9 Other problems

As discussed, farmers now have to face new challenges such as drought and price volatility. In many cases, what people learned from their parents does not offer solutions to these challenges. Therefore, it follows that other immediate sources of information are necessary. All villages have an extension officer but although this person is present, it does not necessarily mean that he or she is also a reliable resource for farmers. In Ilolo and Changarawe, farmers complained about the availability of the extension officer, especially

right in the field where they would be needed. Some people did not even know who the extension officer actually is.

In Ilolo, farmers also did not perceive the village government as a reliable source:

> "When the village chairmen calls a meeting in the sense that he wants to educate villagers about agriculture while his own farm performs very poor, people won't come." (Problem tree crop, Ilolo, 18.02.2014, Man)

New agricultural knowledge and information is rather gained in exchange with neighbors or neighboring villages, by travelling and through the radio. For example, rice was introduced to Idifu because it first started in the neighboring village and Idifu farmers then adopted it. Different capital endowment is the main criteria for villagers to differentiate among each other very strictly into "poor" and "rich". The limitations in capital as well as the according differences in resource endowment and accessibility lead to different depth of problems in crop farming and are making the rural poor most vulnerable for sudden environmental changes.

3 Preliminary discussion

Land endowment was a major distinguishing feature of farmers in the CSS: richer farmers usually have more fertile and bigger farms.

Villagers reported: "In the same village there are people with money that can buy fertile land, there are those with money to rent and there are also those with low income who remain in their inherited lands" (Net map, men, Changarawe).

Richer farmers usually have more fertile and bigger farms as a good precondition for higher outputs. A triggering resource is the equipment for farm preparation: while those who can afford a tractor (M) or oxen (D) manage to farm on bigger areas, others only using hand hoe are restricted to smaller farm sizes due to labor and time demand and face additional problems in fertility. Rich farmers have due to access and availability to inputs like e.g. animal manure in Dodoma and equipment like tractors in Morogoro more options to influence production conditions to a certain extent, hence do also engage in more risky but also more lucrative cash crop and vegetable cultivation. Cash crops like e.g. Simsim have a higher demand on artificial inputs especially pesticides and are hence farmed in majority by those who can also afford these inputs. Good market contacts outside the village enable them to sell for a higher price and additionally also to buy and trade the harvest of their poor neighbors with less trade capacity. Getting more from agriculture is generating a capital stock that is offering opportunities to diversify income generating activities and at the same time employing others to cover labor intensive agricultural activities.

But the opportunity to do wage labor is bone and bane at once for the rural poor, as it creates a tradeoff between using labor capacity and time to work on the own farm or using labor capacity and time to satisfy family needs, especially in terms of food supply. Following discussion with local people, one such paraphrased example of the "worst case scenario" 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 casual 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.'

The lack of capital for development is thus leading to a vicious circle.

Another important factor to consider is the variation between rich and poor in terms of resilience to climate changes. All participants reported about the strong effects of a drought. Participants expressed that there were several years of drought in a row over the last 3 years, even in the semi-humid Morogoro region.

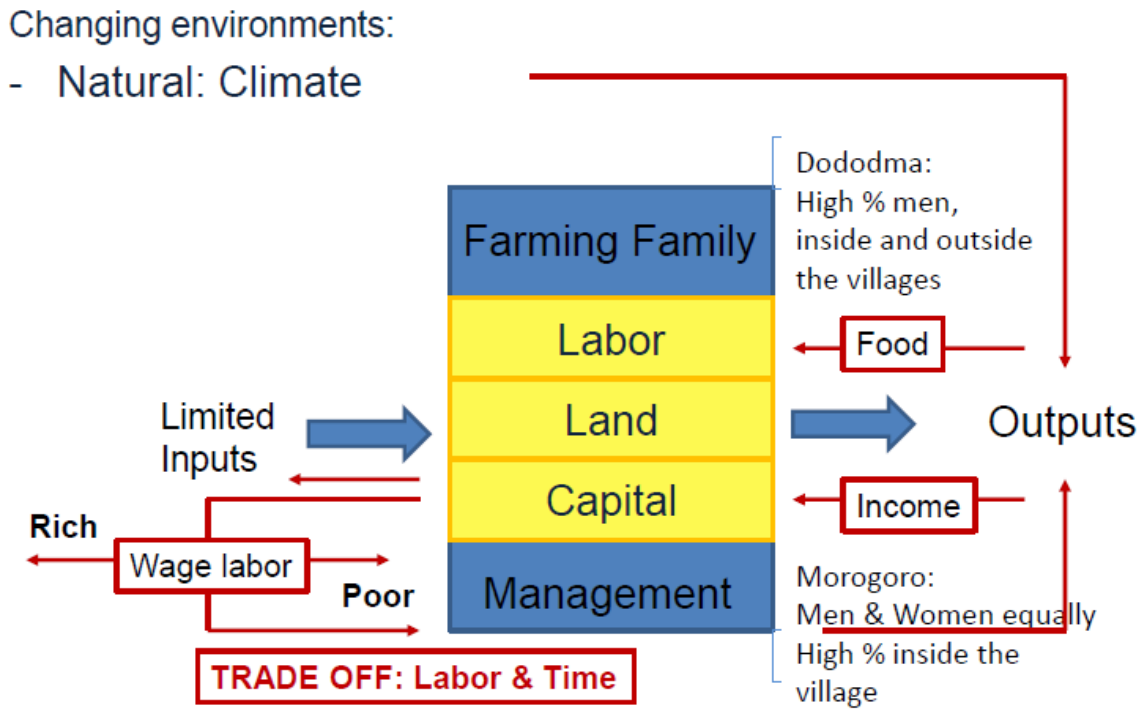


Figure 1 How climate change/events exacerbate the labor-time trade-off

As illustrated in the figure above, this change in the climate has a direct water stress effect on cash and food crops. In Morogoro the main food crop (maize) and in Dodoma the main cash crop (groundnut) were both reported to be strongly affected by drought, with low to no yields. This creates a severe lack in food supply and income, making the farming system more vulnerable and affecting not only the family situation but also labor and capital resources of the farm. According to the different income levels and off farm activities that we discussed, people are differently affected by this situation. For the poor, they were forced to do wage labor on other people's farms to generate immediate income to purchase food. This is

coinciding with their own farm activities during the rainy season and interrupting farm management. It is creating a trade-off for poor farmers between using time for farming on the own farm vs time to satisfy urgent family needs, in the face of limited labor resources.

The results lead to the following preliminary conclusions:

In all CSS, crop farming is the main food and income generating activity for all types of households, so also innovation needs to address problems in crop farming. Nevertheless there are differences in capital endowment of households mainly due to differences in agricultural output and type of off-farm activities. Single female households are especially affected by poverty due to limited opportunities and labor capacity for off-farm activities. While all CSS farmers -rich and poor- are affected by drought events, the poorer farmers are rendered more vulnerable to such events by their lack of capital and resources to cushion the impact. This increases the risk of becoming trapped in the vicious circle described above. During such times, the rural poor face a lack of labor and time to maintain their most important livelihood activity, crop farming.

This has consequences for the identification of innovations: the restrictions in capital and labor of the rural poor are creating a trap for straight forward innovation identification. Innovations can neither be capital nor labor demanding. This informs how to prioritize different solutions and create the need to address innovations beyond the pure farm level.

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