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Learning as conceptual change during community based group interventions. A case study with smallholder farmers in Zambia.

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Abstract

Food and farming systems are both complex and dynamic in nature. While smallholder farmers hold great practice-based knowledge, rapidly changing and ever more challenging framework conditions require them to constantly learn and adapt to change. Understanding knowledge change is important to improve the design of shared learning experiences, especially as they are one prerequisite for the effective implementation of adaptive policies. This paper studies knowledge change within smallholder farmers in Zambia as a result of systems thinking group interventions. We report on the design, implementation and preliminary analysis of two group workshops with ten smallholder farmers each and follow-up interviews with some of the participants. Our results so far suggest that the use of system maps and collaboratively unfolding them seem crucial components in the process of knowledge change. Thanks to the system map, participants display a fairly high degree of convergence on systemic issues and policy considerations during post-workshop interviews. Their explanations of challenges and possible options to overcome them are not limited to the available visual components of the collaboratively developed system map. Instead, participants extend the discussion of options beyond the system map while remaining able to reason in a concise, systemic way.

"The lesson is very much important in someone's life and is better than these other gifts."

Participant after receiving a group picture as a token of appreciation for taking time for a follow-up interview.

Introduction

Food and farming systems are both complex and dynamic in nature. They require stakeholders to constantly learn and adapt to change, especially in the face of expected long-term climate change and situations causing short- to medium-term food insecurities, such as local weather, storage insufficiency, singular crop dependency or economic precariousness (Ericksen 2008, Folke et al. 2005). While smallholder farmers hold great practice-based knowledge about the farming and food system, it is believed that both the integration of different local knowledge bases and the integration of local and science-based knowledge increases adaptive capacity of those dependent on and regularly interacting with the system (Berkes et al. 2003, Mackinson & Nøttestad 1998). However, to learn is not only to add new knowledge but the transformation and creation of understanding during a learning process. Conceptual change theories explore possible learning mechanisms, such as mental model building, knowledge integration or socially situated tool appropriation (Mayer, 2002). The field of System Dynamics and system thinking has a long tradition in facilitating learning about complex systems, through the use of models (Sterman 2001, Lane 1992, Vennix 1996). Mediated modeling or community based group model building uses the methodology to build local knowledge capacity and improve decision making in dynamic settings (Metcalf 2010, Hovmand, 2014). While there has been extensive research on learning outcomes such as performance or differences between prior and posterior understanding, little research has been done to understand how exactly conceptual change takes place in the course of System Dynamics and system thinking learning interventions (Kopainsky & Saldarriaga, 2012). However, to better understand the unfolding of conceptual change during a system thinking intervention can potentially give valuable insight to future design and expected deliverables of such interventions as well as increase the ability of practitioners to meaningfully embed them in various contexts.

This paper reports on the research into how knowledge change within smallholder farmers corresponds to the use of qualitative system models and systems thinking group interventions as part of a broader attempt to equip them with effective and sustainable short-and long-term strategies to increase their food security as well as ensure their economic stability. The study aims at uncovering mechanisms that promote conceptual change, particularly the integration of diverse local as well as science-based knowledge during the course of a facilitated systems thinking group intervention to inform future intervention planning and design in the community learning field.

In order to reach the objectives the following research questions need to be answered:

A1. What does farmer's knowledge look like after a facilitated systems thinking group intervention?
B1. What mechanisms can be identified that facilitate or inhibit knowledge change?
B2. How does farmer's knowledge and understanding of the farming and food system develop in the course of a facilitated systems thinking group intervention?

Research Design

Analytical Framework and Definitions of Concepts

Figure 1 shows the analytical framework for the study including research (left column) that was conducted by Spicer (2015). The research design is based on considerations in multiple fields, amongst which are: the learning sciences, particularly conceptual change theories (Limón & Mason 2002; Parnafes et al. 2008; Greeno & van de Sande 2007), facilitated modeling, particularly group model building and community based system dynamics (Vennix 1996; Franco & Montibeller 2010; Hovmand 2014), and systems thinking, particularly qualitative system dynamics (Lane 1995; Wolstenholme 1999). The fields of facilitated modeling and systems thinking inform the stage of intervention design. They provide methods for group modeling (incl. diagrams, sign systems and procedural conventions) as well as content and definitions for knowledge analysis, such as dynamic system concepts or systemic reasoning levels. The learning sciences offer procedures and frameworks for the study of shared learning processes.

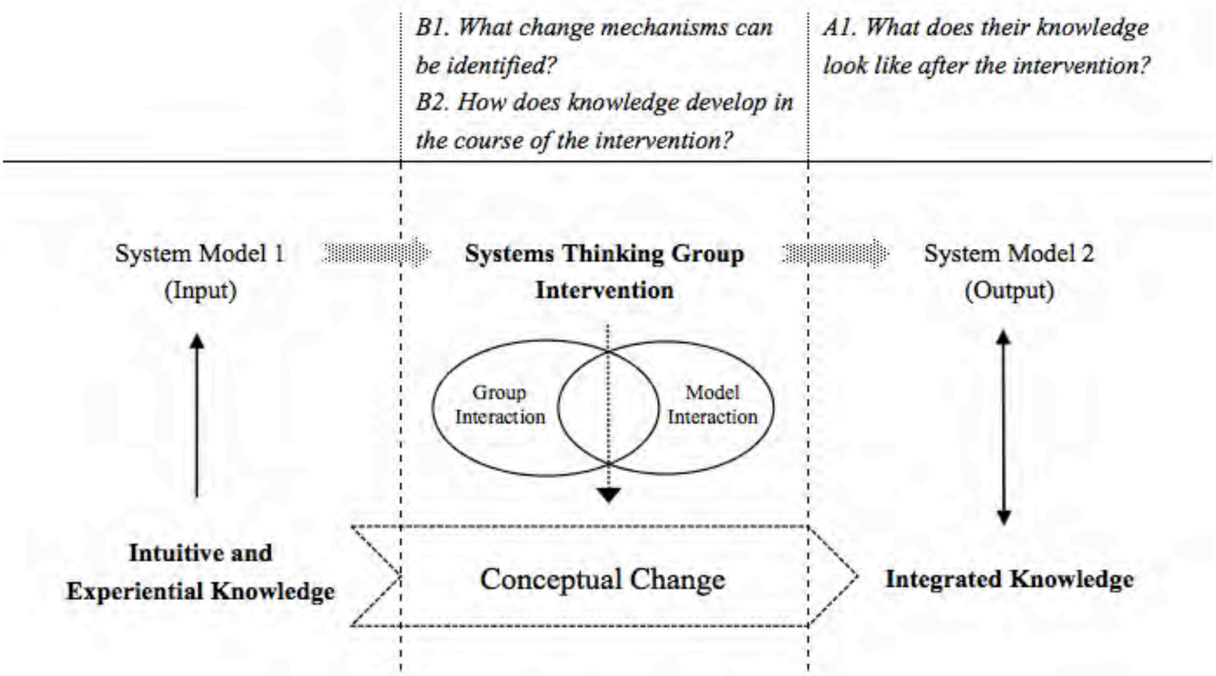

Figure 1: Research questions and analytical framework of conceptual knowledge change in the course of a systems thinking group intervention using qualitative system models

System models as used in this framework serve different purposes. On the one hand, they are defined as conceptual artifacts and interpretive maps of understanding inductively derived from interview data (Kim & Andersen 2012). On the other hand, they are seen as transitional or boundary objects (Franco 2013; Hovmand 2014), or so-called "things to think with" (Roepstorff 2008) jointly created during a systems thinking intervention offering specific affordances to the learners. The notion of boundary objects has been used and supported in the field of participatory modeling and group model building to capture the innate purpose and function of diagrams in shared learning experiences (Scott et al. 2014; Black & Andersen 2012; Paroutis et al. 2015). Diagrams qualify as boundary objects if they help a group develop or use shared language (syntactic boundary), shared content (semantic boundary), and a shared vision for action (pragmatic boundary). Well-known characteristics or affordances of system diagrams are their tangibility, mutability and associability. They come in one tangible form that can be perceived by all participants, they can be changed on the spot and they visualize relationships and dependencies amongst aspects relevant to the participants (Black & Andersen 2012; Paroutis et al. 2015). *Conceptual change* is broadly understood as a process of learning and knowledge development (Mayer 2002). We use the terms conceptual change, conceptual development and knowledge development interchangeably. More specifically, conceptual change is framed here in accordance with Greeno and van de Sande's (2007) integrated view of situated and distributed cognition. It is seen as changing and achieving coherent states of understanding through participation and interaction in groups.

Methodology

Given the qualitative nature of the research questions, the small sample and the fairly natural context of the study, the research strategy follows a qualitative approach and is carried out as a mixed-methods case study. The types of knowledge gained are explanatory (B1) and descriptive (A1, B2). The data was collected in form of audio/videotaped (participant) observation as well as semi-structured interviews.

Knowledge analysis (Parnafes et al., 2008) is directed at research questions A1, B1 and B2. Knowledge analysis attempts to identify and track changes in categories/units of knowledge held by the participants and to investigate knowledge integration during the intervention as well as during post-intervention interviews.

Knowledge analysis is complemented by interaction and conversation analysis used in the group learning and group model building literature as well as the soft OR field associated with facilitated modeling (cf. Canary and Seibold 2010, diSessa 2007, Jordan and Henderson 1995, Franco and Rouwette 2011) to fully exploit possible insights to research questions B1 and B2. Two dimensions of interaction are interesting to consider:

1. The interaction between group members during the intervention, as well as
2. The interaction of group members with the model.

Case Study

Case study region

Zambia, officially the Republic of Zambia, is a landlocked country in Sub-Saharan Africa. It lies south of the Democratic Republic of Congo and Tanzania, north of Mozambique, Zimbabwe, Botswana and Namibia and shares boarders with Angola to the west and Malawi to the east. According to the Center for International Futures, its population in 2015 is estimated at 15 million people with a very high annual growth rate of 2.77 % and a projected doubling of its population from about 15 million in 2015 to 30 million in 2045. With an area of roughly 750,000 sq. km it remains having low population density (compare with Turkey: it has a similar size but a population of 80 million). In 2012 nearly two thirds of the country area were covered by forest and 30% were used for agriculture (FAO, Food and Agriculture Organization of the United Nations). Zambia also faces major challenges. Almost 30% of its urban and 80% of its rural population live below the national poverty line of 1.25$/day PPP (Millennium Development Goals Indicators, United Nations Statistics Division). The Global Food Security Index places it amongst the 10 most food insecure countries globally with little less than half of its population qualifying as undernourished. Zambia scores absolute lows on food affordability, quality and safety (105 out of 109 countries) and low on food availability (83 out of 109).

Historically, Zambia's economy and most of its export volume is dependent on the copper industry. However, as of 2012, 56% of its total labor force worked in agriculture, with an average of 80% in rural areas (2012 Labour Force Survey, Central Statistical Office Zambia). The national's crop number one is maize, followed by groundnuts, cotton, soybeans and mixed beans, sunflower, sweet potatoes, wheat, millet, rice, sorghum and tobacco. Smallholders account for the vast majority of farms, cropped area, maize production, and fertilizer use. Agriculture and agricultural practices face multiple challenges, affecting small- and medium-scale farmers most. Accessibility to functioning market and transportation infrastructure is lacking. Frequently, farmers cannot afford or access inputs such as seeds, fertilizers, or herbicides at a reasonable price and at the right time. Especially small-scale farmers have no options for or knowledge of proper financial management and services, let alone access to long-term investments. At the same time, small-scale farming practices tied to staple crop production are often unbalanced and result in soil erosion and a loss in soil fertility, which destabilizes productivity in the long run (Neubert et al. 2011). Furthermore, external drivers, such as climate change and economic shocks, are posing increasingly significant challenges to the agricultural sector. The region has seen a rise in mean temperature over the last four

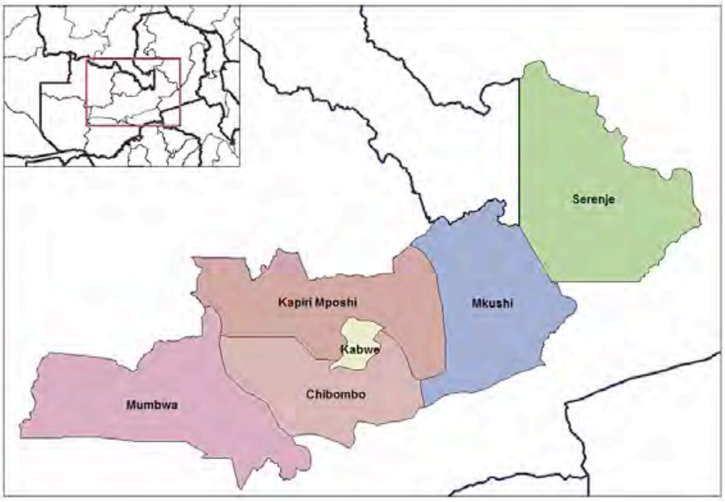

Figure 2: Chibombo District in Central Province, Zambia. (Source: http://en.wikipedia.org/wiki/Districts_of_Zambia)

decades. Furthermore, rainfall patterns have changed significantly since the late 1980s (de Wit 2006; Fumpa-Makano 2011).

In this paper, we present data from two workshops and corresponding follow-up interviews in Chisombo district. Chibombo district is located in Central Province between the country's capital Lusaka and Kabwe (Figure 2). It is about 90 km to the north of Lusaka and is largely a farming district where about 90% of the district population depend on agriculture for their livelihoods. The district recieves rainfall between 800 and 1200 mm per year. Climatic conditions make it suitable for production of maize, cotton, sunflower, cowpeas, beans, groundnuts, paprika, soya beans, and tobacco etc. The agricultural sector is characterized by a mixture of commercial and small-scale farmers. Over seventy-five (75%) of crop production in the district is done by small scale farmers and commercial agriculture is largely concentrated in the south of the district. Our case study villages, Chitumbo and Mpikwa, are located in the north of the district where small-scale agriculture is dominant.

Participants

Workshop participants were recruited from two villages in Chibombo district, namely Chitumbo and Mpikwa village. An initial listing of all the farmers in the two villages provided an overview of their respective socio-economic characteristics such as household size, farm size, animal stock, education level, asset endowment, input use, planting time and planting method. Based on these characteristics, ten participants from each village were selected for the workshops. Participants were household heads, five of them female and five of them male in each workshop. Additional selection criteria included the representation of diverse socio-economic household characteristics and the willingness of participants to attend the workshop without payment. At the end of each workshop, we distributed some basic household items as a token of appreciation. However, farmers' motivation to attend was interest rather than the promise of any payment.

Intervention Design

Pre-workshop considerations

The starting point for preparing the two workshops was a basic causal loop diagram (CLD) that represented the main feedback loops driving household food security. The CLD is based on in-depth interviews with 20 small-scale farmers in four regions in Zambia. Four of the workshop participants from worshop 1 had taken part in those interviews. The interviews focused on small-scale farmers' dynamic decision making in the context of food security and livelihoods (see section on data collection for further information).

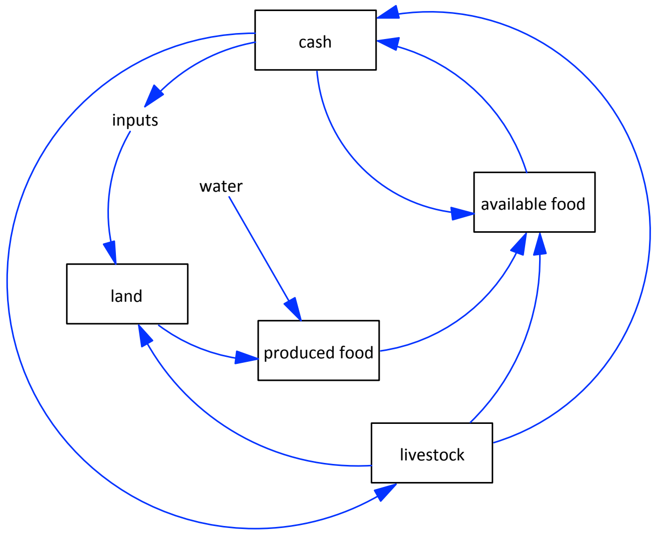

Figure 3: CLD as a workshop starting point

Figure 3 shows the base CLD used for the workshop design. It links the key stock variables through two major reinforcing feedback loops. Available financial assets (“cash”), the amount of food produced in a year (“produced food”) and the actual food security situation (“available food”) are at the heart of farmers’ concerns. The more cash a household has available, the more inputs (fertilizer, seed, herbicides) they can purchase. More inputs allow farmers to cultivate more land and thus increase the amount of food they produce. Some of this food is sold directly (cash crops) and some is only sold if there is any surplus between what is produced and what is required to feed the household (represented in the variable “available food”). The more a household can sell, the more income they generate which adds to the stock of cash. A similar reinforcing feedback loop links livestock to cash (through sales of animal products or animals) and back to livestock (through purchases of additional livestock). Note that Figure 3 only describes the reinforcing loops that either drive the accumulation of food and financial assets or lead to their continuous depletion, depending on whether a household manages to exceed a critical resource threshold (cf. Stephens et al., 2012). The figure does not show the manifold balancing feedback loops that regulate the accumulation of the stocks and the operation of the loops. Instead, it focuses on the main structure relevant for explaining the notion of vicious and virtuous cycles and the existence of thresholds that determine loop direction. For similar reasons of clarity and simplicity, we did not indicate the polarity of the relationships in the diagram. For the processes displayed in Figure 3 this was not crucial.

The workshop design resembled a basic form of group model building (Vennix 1996, Hovmand 2014) using qualitative system models. Figure 6 illustrates the different phases of the participatory process. The workshops lasted between 2.5 and 3.5 hours each.

Workshop phase one

The diagram as shown in Figure 3 primarily served as a mental guiding aid for us as workshop facilitators. We started by subsequently putting all seven variables on the table and discussed them without yet connecting them. Instead, we used visual and tangible objectes to make sure that participants agreed on variable names and what these variables represented. Figure 4 shows the diagram from the first workshop with the variable names written on a piece of paper, complemented with pictures and tangible objects supporting the meaning of the variable as well as a participant actively placing a bag of harvested seeds on the available food variable.

Figure 4: Placing objects (seeds, fertilizer, salt, coins etc.) and pictures to develop a shared understanding of meanings of variables.

Workshop phase two
After introducing the variables, we gradually linked them until the two main feedback loops were complete.

Workshop phase three
For illustrating the mechanism of the two loops, we used glasses for each of the stock variables. Participants gradually and consequitively filled them with water to their desired levels as we collaboratively unfolded the operation of the reinforcing processes. Figure 5 shows the diagram with pictures, objects and glasses for four of the five stock variables.

Workshop phase four
Subsequently, we focused on the discussion of stresses on the system (processes that "drain the glasses") and available options to shift loop direction towards a virtuous cycle and to increase accumulation in the respective resource stocks.

Figure 5: Representation of stocks and levels in the system model with pictures, objects and water glasses

Figure 6: Different stages of the participatory model building process

Post-workshop interviews

The interviews were conducted one week after the workshops, asking open questions about (1) structural components of the system of interest (resembling variables, causal structures, loops), (2) policy options for averting unfavorable stock levels as well as their dynamic implications, (3) the use of objects, pictures and visual diagram properties, such as arrows and loops, (4) potentially unresolved disagreements with what had been discussed during the workshop, (5) moments of surprise during the workshop, (6) potentially “new insights” gained as well as key lessons learnt, and (7) participant’s impression on the participatory method in contrast to more commonly used methods in theoretical rural farmer education, such as lecturing. The interviews were supported by prints of pictures of the final workshop diagrams (Figure 8 and 9 respectively) as the goal was to better understand if the participants could use the diagrams in a meaningful way, and not to plainly test whether they had memorized anything from the workshop.

Data Collection

The primary sources of the research are videos of the group workshops conducted by two of the authors (BK, PN) as well as transcriptions of the videos, translated from Tonga to English (cross-checked by PN). A further primary source are semi-structured post-workshop interviews, also in the form of videos and translated transcripts.

A base CLD of farmer’s understanding of their food and farming system (Figure 3) is used as a secondary data source. It functions as a starting point for the group intervention as well as a reference point for subsequent analyses of conceptual change. Spicer (2015) inductively developed the CLD using primary data from in debth interviews (Saldarriaga et al., 2014). For the purpose of the workshops, the diagram was simplified as much as possible.

Data Analysis

Part 1 – Analyzing mediated conversational action (research questions B1 and B2)

(i) To analyze the workshop transcript we looked for coding schemes that had been used in similar contexts and considered similar theoretical implications. We compared different existing approaches and coding schemes for analyzing conversational interaction in collaborative learning settings (Roschelle 1992; Hmelo-Silver 2003; van Boxtel et al. 2000; Fischer et al. 2002; Arvaja et al. 2007; Mercer 2004; Kumpulainen & Mutanen 1999). We decided to use Canary and Seibold's (2010) Conversational Argument Coding Scheme (CACS), which allows for a close look into verbal communicative interaction between people. It focuses on and is limited to the communicative function of people’s utterances in their attempt to find agreement and “reach accord with the minds and behaviors” (ibid, p.12) of others. The unit of analysis is the vocalized thought or speech turn, most often an independent utterance indicating an idea or distinct thought. If an idea or support for it changes, a new thought turn is present. The scheme distinguishes between starting points of an argumentative structure, developing points, convergence markers, prompters and delimiters. Apart from being a coding scheme for conversational interaction, it also offers a systematic frame for the interpretation of different types of argument structures. The entire workshop transcript was coded using the CACS following the CACS manual (Canary, 1992).

(ii) Inspired by Paroutis et al. (2015) we take an inductive approach to analyze tool use and tool-mediated interaction. Accordingly, we code the entire session based on how participants use and interact upon the central diagram.

(iii) Furthermore, we draw on the idea of diagram affordances as applied in the operational research and System Dynamics field (Franco 2013; Paroutis et al. 2015; Black & Andersen 2012) and insights on the role of visual representations in group learning situations (Suthers 2005). The aim is to expand on the potential role of system diagrams used in community-based system thinking workshops.

Part 2 – Analyzing conceptual change towards shared systems understanding (reseach questions A1 and B2)

(i) Given the assumption that we are able to phenomenologically capture some of those processes, we coarsely identify episodes in the workshops, within which conceptual change may have take place. The identification is based on descriptions of conceptual change as synthesizing prior knowledge with new experiences, repairing conflicting conceptions through replacement and organizing pieces of knowledge and socially forming agreement upon the use of tools (Mayer, 2002) as well as the notion of convergence as a potential indicator in collaborative settings (Roschelle, 1992). Then, we qualitatively analyze those episodes and describe the unfolding of knowledge change across types and qualities of knowledge (de Jong and Ferguson-Hessler, 1996) in relation to Hopper and Stave's (2008) Taxonomy of System Thinking Characteristics.

(ii) We triangulate the results by drawing on interview data collected one week after the workshops. Given that the participants had no prior training of causal mapping or explicit socio-ecological systems thinking, if collaborative conceptual change has taken place to some degree and it was of convergent form, we would at least expect to see (1) a person's ability to handle the diagram and its logic to recollect and form causal chain and loop arguments as well as make dynamic inferences relating to the contents discussed during the workshop, (2) evaluations of the tools used resembling an understanding of their intended purposes and (3) a fair amount of overlapping responses from participants. As regards (1) and (3), a compiled system map is created inductively based on the information shared in the interviews displaying matching parts between individuals as well as further individual contributions. The map is complemented by short sequences and analyses of literal explanations from participants to assess the nature of their argumentation. (2) is achieved by collecting, comparing and analyzing participant's responses to evaluate the tools and concepts used during the workshop.

Results

They results from the detailed analysis suggest that knowledge integration of local based knowledge with science-based systemic knowledge can be facilitated through community based system thinking workshops using system models.

There are five distinct and constitutive system concepts required for the farmers in this case study to develop an intermediate level of system understanding that equips them with systemic reasoning capacity and some basic form of systemic conceptual agency:

- The concept of variables as independent ontological entities, disentangled from their daily and procedural use
- The conceptual understanding of causal relations between those entities (incl. notion of their "nature")
- The conception of a closed loop
- The concept of stock levels, and
- The concept of reinforcement.

To develop the above concepts, participants engage in a collaborative effort to establish shared understanding. In order to do so, they change qualitative knowledge aspects and transition in-between knowledge types. Also, two knowledge domains are at play at the same time and overlap: knowledge of the farming and food domain, and knowledge of the systems thinking domain. Finally, the further the process of system mapping, the less intense becomes the conceptual learning effort but the more complex and fluid becomes knowledge integration. In other words, while in the beginning participants are busy developing understanding on concepts from a systems perspective, in the end they are busy integrating them with other forms of knowledge in more complex tasks such as strategy development and evaluation.

The role of using system models and the process of collaboratively and interactively unfolding the model are crutial components in the process of conceptual change. With the system map at hand, participants display a fairly high degree of convergence on systemic issues and policy considerations during the post-workshop interviews. They also converge on their use of language, their ability to meaningfully draw connections between crucial variables and identify loops, which is in stark contrast to Spicer (2015), who discusses the challenges of coding the multi-faceted uses of language and meanings in their in-debth interviews. Interestingly, the explanations given are not limited to the available visual components of the diagram (Figure 8 and 9 respectively). In fact, participants extend the discussion of issues beyond the visible while remaining able to reason in a concise, systemic way. Figure 7 shows the synthezised representation of verbal expressions of system features of three interview transcripts, which together with the qualitative analysis of individual's statements serves as a partial answer to research question A1.

Literal excerpt from one of the post-workshop interviews:

> *"From cash I come here on inputs because when you have cash you can buy inputs, after buying inputs I come to land but before I come to land first it will rain and after it has rained I get the inputs and then plant. When I finish I come here on food produced, this same food produced I will reserve some for food and the surplus i will sell to have cash again. Then from this cash after selling of the surplus food I come and buy some livestock. The good part of the livestock is that they provide us with the manure such as chicken manure or any other animal manure which we use to marinating our soil fertility since we talked about the ways of maintains the soil."*

The causal chain described is extensive and it includes the major production loop, as well as the cash-livestock-manure loop, which feeds back into the production loop through soil fertility. What's more, it is far from being a mere recitation going around the visually available loops in the diagram. This becomes clear in the explicit portrayal and discussion of parts within the system where multiple factors interconnect (the separation of food produced into surplus food for sale and food for consumption and the dependence of cultivation of land on rain). It is also visible in the value statement of appreciation of livestock ("The good part of the livestock is that…") as providing positive influence on another part of the system, namely soil fertility and its function to maintain productivity of the land.

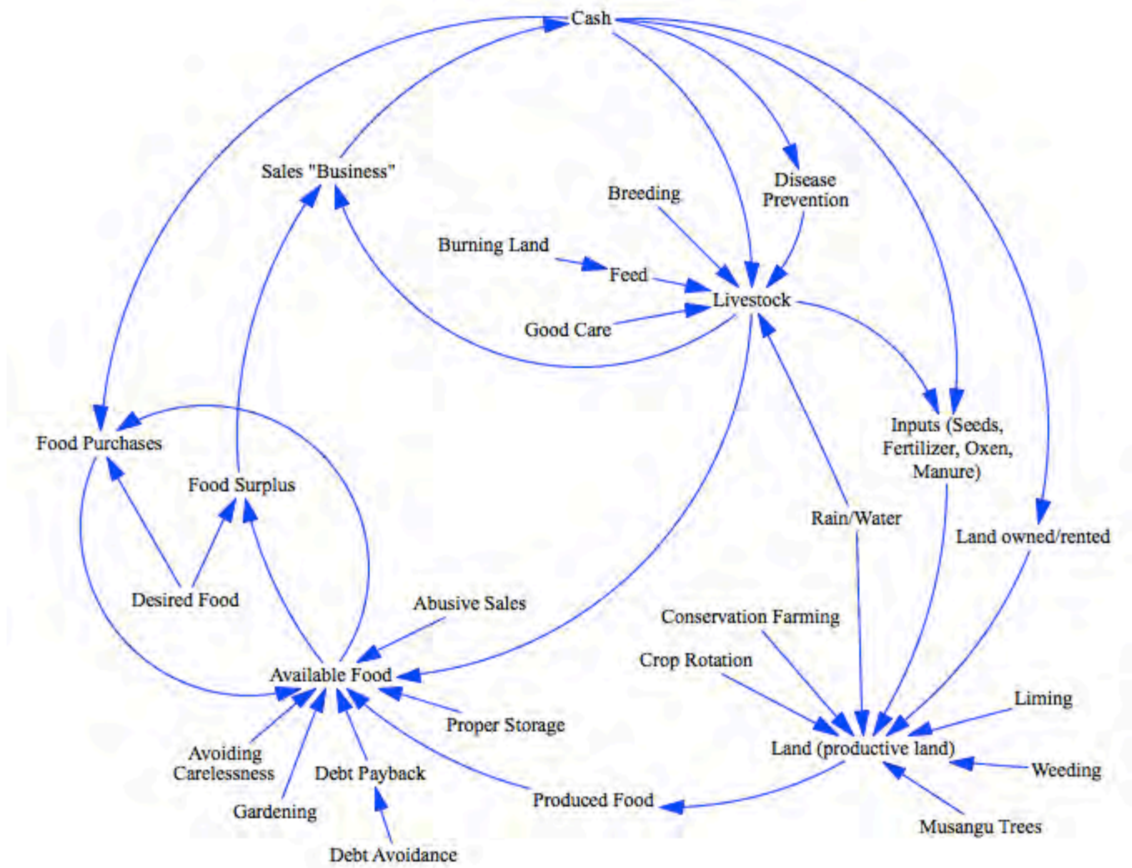

Figure 7: Map of participant's causal chain descriptions shared in three interviews following workshop 2

More than anything, Figure 7 provides a visual representation of the participants' ability to actively use the diagram at hand to verbally recreate and share understanding of a multiloop system in a causally consistent manner, actively responding to and therfore framing it according to the interviewer's questions and focus on potentialities.

Furthermore, we are able to approximate research questions B1 and B2. The use of tangible objects was important in two ways. First, the pictures and objects representing variable names urged participants to agree on the terminology as well as the meaning of variables before they proceeded to building the system model and discussing shocks and adaptation options. This discussion also helped illustrating the notion of causality. For example, some of the participants repeatedly placed the picture and also the physical object representing inputs on the land variable and explained that inputs allowed them to cultivate more land. The disentanglement of the procedural aspect of “inputs go on the land” and categorical aspects (land differs from inputs) as well as their relationship enabled a brief discussion on the differentiation between cause and effect.

Figure 8: Final system model resulting from workshop 1

Second, the water glass analogy was powerful for illustrating the behavior a reinforcing feedback loop gives rise to. In addition, it provided a crucial anchoring point for the subsequent discussion of stresses to the system and available options to shift loop direction towards a virtuous cycle and to increase accumulation in the respective resource stocks. The water glasses provided an intuitive way of seeing stresses to the system as processes that drain the glasses and available options as possibilities to (re)fill the glasses. The terms “draining the glasses” and “filling the glasses” occurred repeatedly throughout the workshops. Participants intuitively integrated them to illustrate their comments and evaluations, without further probing by the facilitators.

Figure 9: Final system model resulting from workshop 2

Discussion and conclusions

The purpose of this paper is to report on the study of knowledge change in smallholder farmers in Zambia who were exposed to a group systems thinking intervention. In the course of approximately three hours, participants went through the entire process of building and analyzing a conceptual system dynamics model. Insights into the way in which their knowledge changed and the factors that facilitated or inhibited this process are important in two regards.

On the one hand, they provide a basis for the design of effective strategies that increase farmers' adaptive capacity in the long term. The complexity and diversity of farming systems and the range of uncertainty they face are such that there are no universal practices and technologies for achieving and maintaining food security and other food system outcomes (e.g. Janssen & Anderies, 2013). It is therefore crucial that smallholder farmers understand the direct as well as indirect impacts of available practices and technologies and that they are able to adjust them to their specific circumstances.

On the other hand, the insights from the workshops in Zambia have important methodological implications. The conditions for community based systems thinking interventions in rural Zambia with smallholder farmers differ to a fair extent from contexts within which group model building has traditionally been employed and conducted (cf. Vennix 1996, Rouwette and Vennix, 2006). Even participatory modeling in social-ecological contexts primarily include stakeholders with institutional affiliations rather than groups often marginalized and unrecognized in formal decision making contexts (Metcalf et al. 2010, Beall and Zeali 2008, Suwarno et al. 2009). Also, the community based process faces what might be perceived as particular limitations, especially when embarking on from a system dynamics perspective. Apart from a few, the participants have rather low levels of education (basic levels of reading, writing and arithmetic) or no formal education at all. Furthermore, the materials meaningfully available for such interventions lack computers, presentation screens or projectors, which makes quantitative modeling and simulation rather impossible. This research is therefore one of the comparatively few attempts to expand the field to such new target groups and contexts. And the results as described are promising.

On a more anecdotal note, at the end of the post-workshop interview, one of the participants was very motivated to have us return in some time so he could share what they had achieved by adopting some of the discussed options based on insights from the workshop. However anecdotal, it makes clear a sense of empowerment and commitment to action in the participant. The question remains, and is a vast field for future research, whether and how that commitment can be sustained and transformed into meaningful action. It also remains unclear whether some rather simple heuristic of “trying to keep the cups full” – to monitor and employ options to keep or increase stock levels – and the focus on potentialities in the virtuous reinfocing process without explicitely discussing the complete structure in use can partially guide informed decision making and behavior change in the long run.

Finally, and relating back the insights to the practicing field of systems thinking and system dynamics we offer new variations of methodological tools for system thinking and group model building for community-based system dynamcis, which can also potentially result in new group model building scripts for Scriptapedia (Hovmand et al. 2011). Amongst them are scripts for variable clarification through the use of tangibles and pictures as well as definition of desired states and illustrating dynamics using glass cups and liquid.

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