Fertile grounds?

Collective strategies and the political ecology of soil management in Uganda

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Elina Andersson

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Abstract

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The research shows that effective responses to land degradation must acknowledge the multiple stressors of smallholder farming and thus go beyond current technocratic and managerial approaches. To do this, soil fertility decline is best understood as a socially, politically and agro-ecologically integrated issue. Collective action mediated by farmer groups, in which women in particular engage, can be a significant response to everyday constraints and vulnerabilities, not only for overcoming barriers that may obstruct individual coping strategies but also for enhancing farmers' capacities to manage land sustainably. However, findings also indicate that collective action is no universal remedy; the ability to participate in and benefit from collective action is socially differentiated and numerous structural barriers limit the type of change that can be achieved through local self-organisation.

In support of sustainability science and sustainability alike, the thesis makes three contributions to ways of 'thinking and doing' political ecology: by engaging critically with narratives on land degradation; by advancing understandings of the merits and limits of collective action in the context of rural livelihoods; and by providing insights on solutions-oriented research.

Key words: political ecology, land degradation, soil fertility, smallholder farmers, collective action, gender, action research, Uganda

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To the memory of Ochieng David Ngereza

The story is in the soil,
keep your ear to the ground
Bright Eyes (2002)

Contents

Abstract

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Elina Andersson

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List of papers

I. Andersson, E., Brogaard, S., Olsson, L. (2011) The political ecology of land degradation. *Annual Review of Environment and Resources*, 36, 295-319.

II. Andersson, E. and Gabrielsson, S. (2012) 'Because of poverty we had to come together': Collective action as a pathway to improved food security in rural Kenya and Uganda. *Journal of International Agricultural Sustainability*, 10:3, 245-262.

III. Andersson, E. Left on their own? Dynamics of farmer cooperation and its limits in sub-Saharan African rural development. Manuscript submitted to a peer-reviewed journal.

IV. Andersson, E. (2014) Turning waste into value: using human urine to enrich soils for sustainable food production in Uganda, *Journal of Cleaner Production*, In press.

The work distribution in the co-authored papers was as follows:

I. Elina Andersson, Sara Brogaard and Lennart Olsson contributed equally in reviewing literature, structuring and writing the paper.

II. Elina Andersson and Sara Gabrielsson contributed equally in combining, analysing and interpreting data from our separate fieldworks in Uganda and Kenya respectively, and in structuring and writing the paper.

1. Soil matters

Healthy, fertile soils are essential for human life to thrive. In sub-Saharan Africa, where the majority of the population lives in rural areas and depends directly on agriculture, the soil is central to livelihoods and life worlds. Besides being a crucial productive resource that enables farming and income generation, it is also a symbolic resource deeply laden with social, cultural and political meanings and values. For instance, it is commonly used as a metaphor for place, identity and belonging (Verma 2001). From an ecological point of view the soil has multiple functions; besides supporting plant growth it plays essential roles in ecosystems and in the global water and carbon cycles (Pidwirny 2013). Soil formation itself is a tremendously slow and complex process and soil is therefore considered a 'finite, fragile and dwindling' resource (Lal 2013:479). This underlines the fundamental importance of sustainable and socially informed soil management.

In this thesis, I take my point of departure in the issues of land degradation and land management among smallholder farmers in south-eastern Uganda, which is a region characterised by high land pressure, persistent poverty and food insecurity. While the country has long been commonly regarded as endowed with naturally high soil fertility and favourable climate (Chenery 1960), the words of the national anthem – *'Oh Uganda! The land that feeds us. By sun and fertile soil grown'* – has lost some of its accuracy over time. Indeed, Uganda is a country where land degradation is widely recognized as a serious concern and it has often featured in debates over the drivers and impacts of the problem (Pender, Place et al. 2006).

While land degradation itself remains an elusive concept, most of the definitions essentially refer to loss in productivity of the land (Blaikie and Brookfield 1987). Soil fertility decline is, along with soil erosion, one of the primary forms of land degradation in sub-Saharan Africa that contribute to low agricultural productivity, rural poverty and food insecurity (Scoones 2001, Sanchez 2002). Basically, soil fertility decline is a gradual process in which essential soil nutrients are lost through crop harvest, leaching, erosion and other loss pathways at a faster rate than they are replenished (Koning and Smaling 2005). The problem interacts with numerous other sustainability challenges, including deforestation and climate change (Jones, Breuning-Madsen et al. 2013, IPCC 2014). Given that land is the most important asset for people in Uganda, with nearly 80 percent of the population depending on smallholder agriculture for their

livelihoods (GoU 2013a) , this poses serious constraints on the achievement of development and sustainability goals.

The problems of land degradation in sub-Saharan Africa are widely reported on in research and well established as a key constraining factor in agriculture. Since the early 1990s, soil fertility decline in particular has been at the top of the agenda of researchers, policy-makers and the international development community (Keeley and Scoones 2000). It is now widely recognised that production increases in agriculture will be hard to realize in many places without improved land management (Sanchez 2002). Yet, how best to respond to the problem remains a contested issue (Scoones 2013). Much of the research and resulting policies on land degradation has been dominated by natural science perspectives and have focused on technological and market-based solutions. There is a tendency to overlook the social, economic and political dimensions of the problem (Scoones 2001, Verma 2001, Ramish 2010). Taking a sustainability science perspective, a fundamental starting point for this research is that the environmental and social dimensions of land degradation are fundamentally intertwined. While land degradation as such is a biophysical problem, its underlying causes, consequences and potential solutions must therefore be understood within the larger social, economic and environmental contexts in which it occurs (Blaikie and Brookfield 1987, Leach and Mearns 1996).

Smallholder agricultural systems in sub-Saharan Africa can be described as 'complex, diverse and risk-prone' (Morton 2007). For this large group of rural producers, farming provides the main source of livelihood and income. Typically relying on family labour and small land holdings, the production is largely subsistence oriented, although farmers are increasingly linked to and impacted by the global market economy (Morton 2007). Farmers are generally afflicted by multiple stressors, where land degradation interacts with persistent poverty, food insecurity and increasing climate variability (Morton 2007, Gabrielsson, Brogaard et al. 2012). Smallholder systems can thereby be conceptualised as "an integrated socio-ecological system of production, reproduction and consumption under pressure" (Jerneck and Olsson 2013:122).

The high complexity and context-specificity of smallholder systems call for place-based research, exploring the diversity, dynamics and social differentiation of farmers' livelihoods and land management strategies (Scoones 2001, Morton 2007, Thompson and Scoones 2009). In line with Ritu Verma (2001), I see farmers' soil management, agricultural practices and overall livelihood strategies as largely intertwined and inseparable. By combining critical and problem-solving research, a key concern in sustainability science (Jerneck, Olsson et al. 2011), I involve Ugandan farmers as research participants to explore the complexity of soil management and local responses to soil fertility decline.

Inspired by feminist political ecology, I particularly seek to understand local experiences and perceptions of environmental change and the concrete, everyday strategies

employed by farmers to cope with and act upon such change, individually and collectively. This includes both strategies relating to the social organisation of agriculture and the use of concrete farming practices. In doing so, I am attentive to the social differentiation of such strategies, of which the gendered division of land, labour and responsibilities is one important aspect.

Understanding the 'everydayness' of soils is particularly important and timely given the ongoing efforts to launch a new Green Revolution with the goal of intensifying and commercialising African agriculture (Toenniessen, Adesina et al. 2008, Sumberg and Thompson 2012). While there is little doubt that the productivity of African agriculture urgently needs to be improved in order to meet present and future demands on food (Hubert, Rosegrant et al. 2010, Foley, Ramankutty et al. 2011), this development raises important issues about the appropriateness, efficiency and conflicting values of various pathways (Leach, Scoones et al. 2010). Despite increasing recognition that conventional, top-down solutions have often failed to achieve development and sustainability goals (IAASTD 2009) the search for "big, technically driven, managerial solutions" seems to remain (Leach, Scoones et al. 2010). This directs the attention not only to narratives around soil fertility issues, that is, how problems are conceptualised by various actors, but also to the concrete solutions for improving the sustainability of agriculture. Underpinned by the normative goal of sustainability science to create pathways towards sustainability, a key objective of this research is therefore to explore how land management strategies that build on context-specific needs and priorities can be improved in collaboration with farmers through transdisciplinary modes of research.

Aim and research questions

Drawing on place-based research in a smallholder community in Tororo district in the highlands of south-eastern Uganda, my objective is to understand how farmers respond to, cope with and shape change in relation to land degradation in a context of multiple stressors. In particular, I focus on various forms of collective strategies to improve the sustainability of agriculture and rural livelihoods. By exploring how soil fertility decline and related problems are understood, experienced and acted upon by various actors working in or on agriculture, my goal is to link local level processes to broader debates and narratives. The research is guided by participatory approaches including action research, reflecting the need to involve local actors in the problem analysis and development of options towards more sustainable land management.

The overall aim of the thesis is thereby to contribute to the understanding and betterment of smallholder farmers' strategies and livelihood opportunities in relation to soil and agriculture, with special attention to collective strategies.

My research questions are as follows:

1) What are the conflicting aspects of major narratives on land degradation in smallholder agriculture, and how does empirically grounded research with smallholder farmers challenge and modify these dominant narratives?
2) How do smallholder farmers initiate, organise and perform collective action, what challenges do they face in that process and what is the actual outcome in terms of land management and rural development?
3) How can place-based transdisciplinary research generate locally anchored knowledge as well as practical solutions in favour of more sustainable soil management strategies?

Outline of the thesis

This thesis is a compilation of four separate papers. While I have allowed them to grow in slightly different directions, they are all firmly grounded in the overarching soil theme. This introductory *kappa* consists of six chapters: following this introductory chapter, where I have presented my aim and research questions, I identify and discuss in Chapter 2 three specific research streams in political ecology that provide the broad entry points and conceptual frame of my research. In Chapter 3, I describe and reflect on my methodological choices and considerations relating to how I have constructed, analysed and interpreted the empirical material. In Chapter 4, I introduce the specific research setting, both in terms of a more detailed presentation of smallholder farming systems, livelihoods, and local perceptions on land degradation in Tororo District, and of the agro-political context in Uganda. In the concluding Chapter 5, I recap the arguments developed in the four papers and reflect on the overall insights and contributions of my research, as well as point to opportunities for future research. Finally, Chapter 6 is a short comment on the next step of this research endeavour. Before moving on to the next chapter, I will briefly outline the four papers the thesis builds on:

Paper I, *The political ecology of land degradation*, which is co-authored with Sara Brogaard and Lennart Olsson, is a review article that sets the overarching context for my research. Structured around three decisive debates on land degradation, of which the debate on soil fertility decline in Africa is one, we explore conflicting narratives and prevailing science-policy gaps. We demonstrate the value of political ecology for exploring diversity and complexity, local-global linkages and social fairness in policy.

Paper II, *'Because of poverty we had to come together': Collective action as a pathway to improved food security in rural Kenya and Uganda*, which is co-authored with Sara Gabrielsson, combines empirical research from our different field sites and draws on the concept of 'communities of practice' to explore processes of collective action among smallholder farmers. We explore the ways in which collective action supports farmers' capacity to cope with change and its concrete contributions to food security and natural resource management.

Paper III, *Left on their own? Dynamics of farmer cooperation and its limits in sub-Saharan African rural development*, is based on my empirical research in Uganda and analyses the social dynamics and micro-politics of collective action among farmers, particularly from a gender perspective. By situating the discussion in the resurgence of interest in farmer organisations in agricultural policy and practice, I explore the structural barriers to collective action and problematize top-down promotion of group-approaches in rural development.

Paper IV, *Turning waste into value: using human urine to enrich soils for sustainable food production in Uganda*, is also empirically based and explores how action research can be employed to envision, implement and evaluate possible solutions to soil fertility problems in collaboration with farmers. Specifically focusing on the use of human urine as a crop fertilizer, I demonstrate how transdisciplinary research can guide sustainability pathways through locally-anchored knowledge while taking the interactions between environmental, technological and social processes seriously.

2. The political ecology of smallholder agriculture and land management

During the past four decades, political ecology scholarship has advanced the analysis of the interactions between social and environmental change. In this chapter, I will situate my research within this broad interdisciplinary field and introduce the entry points and conceptual frames that have guided my work. Importantly, political ecology is an explicit alternative to conventional 'apolitical' ecology (Robbins 2012). Rooted in political economy, and to some extent in critical theory, it developed in reaction to what were perceived as narrow and deterministic views on socio-environmental relations and change, particularly with respect to issues of power (Paulson and Gezon 2004, Blaikie 2008). While the field encompasses a variety of theoretical and methodological orientations, scholars in political ecology share a set of assumptions and perspectives, which have also guided my research.

A fundamental assumption is that "politics is inevitably ecological and that ecology is inherently political" (Robbins 2012:3). This understanding of societal and ecological processes as being fundamentally intertwined calls for an integrated analysis of social and material dimensions of environmental change. For that, political ecologists emphasise the value of place-based research and methodological pluralism (Paulson and Gezon 2004). Furthermore, by focusing on how political-economy systems and relations shape, and are shaped by, the environment and resources, scholars in political ecology illuminate the importance of multi-scale analysis (Bailey and Bryant 1997, Leach, Scoones et al. 2010, Robbins 2012). In that way, drivers of environmental problems are often observed and identified in the larger political and economic context rather than "blamed on proximate and local forces" (Robbins 2012:13) such as population growth or inappropriate resource management practices. Following this, political ecology offers a rich repertoire of critical examinations of representations of 'nature' and of dominant interpretations of environmental problems, including prevalent responses to such problems (Escobar 1999, Adger, Benjaminsen et al. 2001, Paulson and Gezon 2004). Moreover, by focusing on access to and control over resources and social relations of production, political ecology illuminates the many and crucial tensions and conflicts in strategic interests, experiences, knowledges and practices among and between individuals and groups socially differentiated by

overlapping relations of power rooted in class, gender, race and ethnicity (Rocheleau, Thomas-Slayter et al. 1996, Paulson and Gezon 2004).

Finally, issues of social and environmental justice are central in political ecology, which aims not only to explore dimensions of power and marginalisation in processes of environmental change but also the "alternatives, adaptations and creative human action" (Robbins 2012:20) in the face of such changes. The increasing interest among political ecological scholars in collaborative and solutions-oriented research within critical frames highlights its explicit normative stance, which is well suited to how sustainability science aims to combine critical and problem-solving research (Rocheleau 2008, Turner and Robbins 2008, Jerneck, Olsson et al. 2011, Robbins 2012).

In sum, political ecology offers a critical lens for exploring the complex and multi-faceted issues of soil degradation and management in smallholder agriculture, embedded in broader contexts of social, economic and political structures and institutions. It thereby also provides a broad and useful frame for linking local level processes and everyday struggles to large-scale political-economic processes and policy narratives.

In the following sections, I identify three specific research streams within political ecology that inspired my work: 1) the critical scrutiny of the dominant scientific interpretations and policy narratives on soil degradation in sub-Saharan Africa, 2) feminist scholarship on gender and other social processes that condition and shape land management and smallholder farming, and 3) the increased attention to a 'practical political ecology' (Rocheleau 2008) attempting to forge a stronger relationship between research and action by engaging with stakeholders in the search for strategies and solutions towards sustainability.

Digging deeper into soil degradation narratives

An important strand of political ecology has drawn attention to how and why certain narratives about environmental problems and processes are constructed and maintained, and what their consequences are in terms of policy prescriptions and interventions (Stott and Sullivan 2000, Robbins 2012). Allan Hoben describes such narratives as: "historically grounded, culturally constructed paradigms that at once describe a problem and prescribe its solution" (1995:1008). Representing a highly programmatic storyline, such narratives become widely perceived, standardised images of environmental change that often have a strong influence on policy and planning (Leach and Mearns 1996, Leach, Scoones et al. 2010). As Hoben observes (1995:1008):

> They do this by structuring options, defining what are to be considered relevant data, and ruling out the consideration of alternative paradigms from the out-set. They are robust, exercising great influence at the preattentive stage of choice, thus discouraging scientific research that can discredit them. They are hard to challenge and slow to change, even in the face of mounting evidence that does not support them.

Although such environmental narratives have been repeatedly challenged by empirical research (e.g. Tiffen, Mortimore et al. 1994, Leach and Mearns 1996, Carswell 2003) showing that "things are rarely what they appear" (Robbins 2012:124), they have still proven strongly persistent. In the case of land degradation, this has resulted in significant gaps between research and policy, as discussed in more detail in Paper I. Political ecology scholars have provided important insights into how and why such narratives get established as 'facts' by demonstrating how their problem framing and solution prescription often fit with prevalent worldviews, suggesting that their claims may serve critical political and economic interests (Lambin, Turner et al. 2001, Leach, Scoones et al. 2010, Forsyth 2013, Bettini and Andersson 2014).

A closer look at the current policy debate on the problem of soil fertility decline in sub-Saharan Africa shows a range of similarities with other environmental narratives scrutinized in political ecology. As discussed in Paper I, this issue has received growing attention during the two last decades and has been pushed to the top of development agendas by a combination of researchers, donors and private-sector actors (Keeley and Scoones 2000). A large number of programmes and initiatives have been launched to tackle the supposedly looming 'soil fertility crisis'. The Comprehensive African Agricultural Development Program (CAADP), the Alliance of a Green Revolution in Africa (AGRA) and the UN Millennium Project are some of the most prominent. Although there is wide scientific agreement that low and declining soil fertility is a serious problem for many farmers (Scoones 2001, Sanchez 2002), it remains a much contested issue, both in terms of problem-framing and suggested solutions. This debate is reviewed in more detail in Paper I, but three salient features which share similarities with many other environmental narratives scrutinized and challenged in political ecology can be indicated here.

Three features of the dominant narrative: cause - effect - solution

First, the dominant narrative on the soil fertility crisis is largely centred on the neo-Malthusian hypothesis of a mutually reinforcing relation between population growth and environmental degradation, inevitably leading to a downward spiral of declining agricultural productivity and deepening poverty (Cleaver and Schreiber 1994). Following this, over-population is often singled out as a prime cause of soil degradation. In a frequently cited study, Julio Henao and Carlos Baanante for example argue that "the current high rates of population density in many [African] countries are already

pressuring the land at levels that exceed its long-term population carrying capacity" (2006:31). Following this logic, 'blame' is put on poor farmers inappropriate land use practices, illustrated by strikingly simplistic and generalized arguments such as: "When people are poverty stricken, desperate and starving, they pass on their sufferings to the land" (Lal 2013:12). Similar to other narratives about environmental change in Africa, the idea of a 'lost Eden' where people once lived in harmony with nature (Hoben 1995) is often echoed in the soil fertility debate, as exemplified by AGRA (2009):

> Traditionally, African farmers have used fallows to maintain soil fertility by allowing fields to go back to bush for a number of years between cultivation cycles (...) As Africa's population pressure increased over the 20th century, the cycles got progressively shorter and soils became increasingly degraded.

Secondly, soil fertility problems are commonly conceptualised and quantified in terms of 'nutrient balances' or 'budgets', and 'soil nutrient mining' has become an established notion in policy formulations (Keeley and Scoones 2000, Ramish 2010). A few but highly influential large-scale assessments of the nutrient flows through African farming systems (e.g. Stoorvogel and Smaling 1990, Henao and Baanante 2006) have significantly shaped the narrative. Based on extrapolation of nutrient calculations from plot and farm levels to national levels in terms of yearly nutrient losses these studies present an alarming picture of the situation as exemplified in the map below (Fig 1).

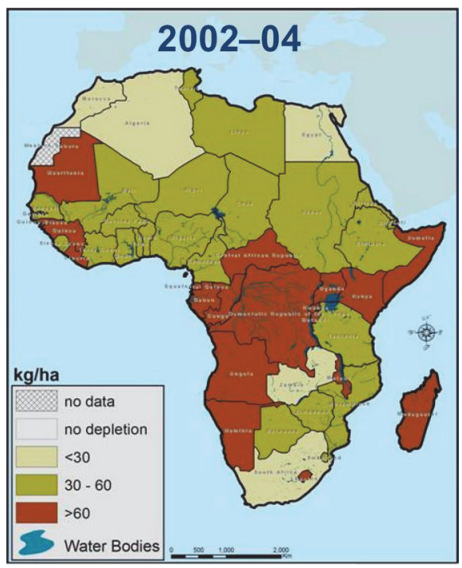

Fig 1. 'Nutrient mining in agricultural lands in Africa' (yearly losses of NPK/ha, 2002-2004). Source: Henao and Baanante (2006):22.

This type of studies and subsequent degradation maps have repeatedly been reproduced in both research and policy, where they along the way tend to become even more simplified and eventually "find a life of its own" (Keeley and Scoones 2000:15). Henao and Baanante state that (2006:x-xi):

> [d]uring the 2002-2004 cropping season, about 85% of African farmland (185 million ha) had nutrient mining rates of more than 30 kg/ha of nutrients yearly, and 40% (95 million ha) had rates greater than 60 kg/ha yearly. These 95 million ha are reaching such a state of degradation that to make them productive again would frequently require investments so large that it will not be economically feasible to implement.

Thirdly, following this logic and reflecting a biophysical perspective on the problem, the dominant narrative largely presents soil fertility decline as a technical and managerial challenge (Ramish 2010). In line with the 'nutrient budgets', there is a widespread use of economic metaphors such as 'recapitalisation of soils' (FAO 1996) and arguments such as: *"Similar to a bank account, it is not possible to take out more soil than what is put in without degrading its quality"* (Lal 2013:12). Although there is wide agreement among researchers that an integrated approach to soil fertility management, combining inorganic and organic fertilizer sources, is required (Vanlauwe and Zingore 2011), the relatively one-sided attention given to inorganic fertilizer remains at the policy level, where the focus is mainly on increasing farmers' access and use and to develop a private-sector-led input market. The goal of the 'Abuja Declaration', signed by the African Union member states, is to achieve a six-fold increase in average fertilizer use 2006-2015 (African Union 2006). It states:

> [F]armers have neither access to nor can they afford the fertilizers needed to add life to their soils. And no region of the world has been able to expand agricultural growth rates, and thus tackle hunger, without increasing fertilizer use. In Africa, use of fertilizer averages only eight kilograms per hectare. In short, Africa is trapped in a fertilizer crisis; this is only 10% of the world average. Addressing Africa's fertilizer crisis therefore requires urgent and bold actions. Africa is ready for the Green Revolution.

Alternative views from political ecology: counter-narratives

Important attempts have been made by scholars in political ecology and beyond to challenge and modify this highly programmatic storyline of cause—effect—solution. Numerous place-based studies on soil fertility issues in smallholder agriculture have emphasised local complexity, diversity and dynamics across time and space in farmers' soil management (e.g. Scoones 1997, Scoones 2001, Verma 2001). By emphasising local knowledge, farmers' adaptability and investment in soil fertility such studies have often served to balance the oft-repeated pessimistic outlooks and generalised statements in the dominant narrative (Leach and Mearns 1996, Koning and Smaling 2005,

Mortimore and Harris 2005). Moreover, there is a general recognition among political ecologists that "demographic explanation is a consistently weak predictor of crisis and change" (Robbins 2012:16). Piers Blaikie and Harold Brookfield (1987) argue in their seminal work that marginalisation is generally a more important driving factor in land degradation processes than population pressure. Building on this, many studies place the problem in a larger historical and institutional context and illustrate that the dominant narrative tends to ignore the larger political economy around soil issues (McCann 1999, Lambin, Turner et al. 2001, Mazzucato and Niemeijer 2002).

Furthermore, 'nutrient budget' calculations have been heavily criticised for methodological weaknesses leading to uncertainties and pitfalls and for failing to capture local spatial and temporal dynamics (e.g. Scoones 2001, Benjaminsen, Aune et al. 2010, Cobo, Dercon et al. 2010), thereby reducing the complexity of soil fertility to "a single elegant number out of context, divorced from all the uncertainties, parameters, and errors that led to that number" (Ramish 2010:27). The political prescriptions flowing from the dominant soil degradation narrative have repeatedly been criticised for being based on 'blueprints of the world' (Adger, Benjaminsen et al. 2001), and thus often unsuitable for local realities. The debates and critiques surrounding the ongoing attempts to launch an 'African Green Revolution' are too extensive to summarize here. However, numerous scholars have highlighted the inappropriateness and failures of 'techno-fix' models to solve soil fertility problems (e.g. de Jager 2007, Ramish 2010). Central to the 'counter-narratives' is the argument that socio-technical solutions always need to be diverse and adapted to the context-specific environmental, economic, social and institutional contexts. The involvement of local land users in agricultural innovation and development processes plays a key role in the formulation of such solutions (Reij and Bayer 2001, de Jager 2007, Turner and Robbins 2008, Röling 2009, Leach, Scoones et al. 2010, Sumberg and Thompson 2012).

Without downplaying the severity of the problem of soil fertility loss, these perspectives have inspired me to take a critical stance against the dominant narrative. In a fuller framing of farming, complete with ecological, social, cultural, economic and political aspects, they offer a more nuanced conceptual basis for understanding soils and their management. My research builds on and contributes to these perspectives. It clearly shows that low and declining soil fertility is a real problem with negative impact on farmers' well-being – indeed one of the main direct reasons for the poor agricultural performance in the area, according to farmers' own analyses. However, the constraints that farmers are faced with in sustaining the productive capacity of their soils must be seen in the larger perspective of social, environmental and political-economic processes at various scales. Furthermore, while there is a tendency in much research and policy to portray people as 'passive victims' of land degradation, my work (especially Paper II and IV) emphasises farmers' agency and the strategies they employ, individually and collectively, in their everyday efforts to make the most of their limited resources.

The social embeddedness of agriculture and soil management

Agriculture and natural resource management are deeply embedded in and shaped by social relations and institutions across time and space. Based on an understanding of social and environmental change as mutually constitutive, political ecology underlines that land management cannot be treated as separate from the social and cultural systems wherein land is used. As already noted by Karl Marx in 1847, "[f]ertility [of the soil] is not so natural a quality as might be thought; it is closely bound up with the social relations of the time" (1963:63 quoted in Foster 1999:375). However, there is a tendency in research on land issues and conventional approaches to land management in Africa to paint a rather one-dimensional picture of farming as "divorced from the social relations of those who do it" (Fairhead and Leach 2005:86).

In the African context, numerous scholars have provided detailed accounts of how farmers' capacities and incentives to maintain and invest in soil are shaped, not only by access to critical resources such as labour, capital, knowledge, technologies, transport and livestock but also by institutions and power structures that determine this access (e.g. Scoones 2001, Verma 2001, Ramish 2010). Soil issues in smallholder farming systems must therefore largely be reframed as social issues (Verma 2001). This illustrates how social institutions, understood as "regularised patterns [e.g. norms, beliefs, procedures, rules and regulations] of behaviour between individuals and groups" (Leach, Mearns et al. 1999:226) influence natural resource management activities which, in turn, shape both the environment and reproduce patterns of social difference. As a result, "[f]ields and soils are the product of social processes over time, just as social actors and their institutions are shaped and conditioned by ecological settings" (Scoones 1997:616).

Gender is a key organising principle of social relations and an important source of power differentials. In the following sections, I will highlight some insights from feminist political ecology scholarship on how gender and other social processes condition and shape land management practices in smallholder agriculture. I will also turn attention to the agency of different actors, that is, people's ability to make decisions, cope with and act upon processes of environmental change, individually and collectively. These perspectives have offered important entry points for my research and have guided my observations both in the field and the subsequent interpretation of data.

The social life of the soil: insights from feminist political ecology

While early studies in political ecology often suffered from gender blindness, feminist insights have during the two last decades made important contributions by highlighting gender as a critical variable influencing social-environmental change. Understood as a deep structure in society shaping roles, rights, responsibilities and expectations of men and women, it manifests itself both in material aspects of resource access and control and in symbolic constructions of masculine and feminine realms, identities and relationships (Rocheleau, Thomas-Slayter et al. 1996, Hovorka 2013). While gender remains a central analytical category, feminist political ecology increasingly recognises that people inhabit 'multiple and fragmented identities' (Elmhirst 2011:131) meaning that gender intersects with multiple forms of social difference including class, race, ethnicity, sexuality, age and place (Paulson and Gezon 2004, Hawkins and Ojeda 2011, Nightingale 2011).

A central concern of feminist political ecology is to broaden the understanding of everyday practices, embodied experiences and the micro-politics of resource use and management within households and communities (Rocheleau, Thomas-Slayter et al. 1996, Truelove 2011). Analysis is often centred on how differentiated resource access and control, as well as risk distribution, pervade social life and shape diverse interests, priorities, knowledges and strategies among individuals and groups (Rocheleau, Thomas-Slayter et al. 1996, Hovorka 2006). One of the most important contributions of feminist thinking to political ecology has been to extend the analysis of power to the household (Rocheleau 2008, Razavi 2009). By politicising a domain conventionally treated as a unit of shared interest and goals, the domestic arena is emphasised as a space of bargaining, cooperation and conflict, characterised by gendered differences regarding resources, responsibilities and rights (Kabeer 1991, Rocheleau, Thomas-Slayter et al. 1996, Quisumbing 2003). Related to this, feminist political ecology also gives prominence to the interconnections between domestic structures and broader political-economic processes in terms of gendered experiences (Razavi 2009).

In the context of land management and degradation, feminist insights have made important contributions to political ecology by exploring how social differentiation in power, resource access, priorities, and practices among social groups are expressed at the household level and beyond (Paulson and Gezon 2004, Rocheleau 2008, Robbins 2012). While there is an enormous complexity and variability among sub-Saharan African farming systems and households, the vast array of studies on gender and agriculture in this region demonstrates that gendered dynamics related to land and labour significantly influences the way soil management is organised in terms of *what* type of investments are made *where*, *when* and by *whom*.

As regards land access, women are largely disadvantaged in land rights and tenure due to inheritance laws and other legal and cultural norms favouring men. In Uganda,

women's access to land is in many cases dependent on their relationship to a male family member (Hundsbæk Pedersen, Spichiger et al. 2012). This suggests that women must navigate in complex 'webs of power' (Ribot and Peluso 2003) to secure land access, which implies that they are differently positioned to influence decisions about how the land will be used and managed (World Bank 2009, Steen 2011). Moreover, because of their generally poor land tenure security, women may be reluctant to make long-term investments in soil fertility in their allocated land plots. In addition, land tenure often influences access to other resources that may be critical in soil management, including extension and credit (World Bank 2009, Esuruku 2010).

The organisation of soil management is also largely influenced by the division of labour and responsibilities within households, as well as by collective action among households. In most households in rural Uganda, labour is governed by cultural norms of rights and responsibilities, with clear expectations of work allocation by gender (Esuruku 2010). Women not only constitute the major workforce in farming but also bear the brunt of domestic work. On top of this, it is to women that major responsibility for community management activities is generally assigned (Quisumbing, Brown et al. 1995, Moser 2003, FAO 2011b). It has been estimated that women provide as much as up to 80 percent of labour in agricultural production in Uganda (Esuruku 2010). This disproportionate burden of labour and responsibilities on women may imply time constraints on the kind and extent of soil management activities (Blackden and Wodon 2006). Many practices involve considerable investments of time and labour, such as collecting animal waste and organic residues for composting, transporting bulky biomass resources, establishing soil conservation structures, and ensuring careful micro-dose application of inorganic fertilizer. The timing of such practices is often critical and may compete with other tasks. Moreover, there is a close relationship between land and labour, especially in terms of women's ability to control the proceeds of their work (Gladwin, Buhr et al. 1997). Subsistence crops are frequently regarded as 'women's crops' while crops for market production tend to be controlled by men (Esuruku 2010). Such gendered cropping patterns often mean that soil investments are concentrated to 'men's fields' (Gladwin, Buhr et al. 1997). Accordingly, the use of inorganic fertilizer and other external inputs tends to be lower in land cultivated by women compared to that controlled by men (Pender, Ssewanyana et al. 2004).

Feminist insights on the household and beyond thereby serve as a critical point of departure for understanding how gender and other social processes condition and shape land management practice in smallholder agriculture. Informed by these perspectives, I have paid close attention to the gendered differences and dynamics in terms of labour, control over land and everyday strategies to secure livelihoods. In Paper II, and to some extent in Paper III, I show that social institutions for collective action play significant roles for women in particular by easing individual barriers to secure livelihoods in an increasingly stressful environment. Not least for female-headed households, who are

generally more constrained in relation to labour, land and access to other critical resources, collective action thereby serves as an important strategy.

The perspectives offered by feminist political ecology demonstrate that any evaluation of soil management practices must go beyond their mere impact on crop productivity to include aspects such as labour requirements, division of benefits and risk within households, as well as impacts on other aspects of the farming system. In current research and development practice this is seldom the case (World Bank 2009). In the collaborative technology experiment outlined in Paper IV we therefore took a broad approach in the evaluation of urine fertilizer and included cultural norms and taboos which may shape gendered differences in adoption.

Navigating change

Political ecology seeks not only to understand how individuals and communities are affected by environmental change but also aims to illuminate people's agency and creativity in the ways such problems are tackled, negotiated and contested (Rocheleau, Thomas-Slayter et al. 1996, Hovorka 2006, Truelove 2011). Paul Robbins refers to these twin goals as 'the hatchet' and 'the seed' of political ecology (2012:99). A focus on agency underlines that social structures, rules and norms are not static; while some actions and practices serve to reproduce and reinforce those structures, others serve to re-interpret and change them (Giddens 1984, Brown and Westaway 2011). As argued by Benedict Kerkvilet (2009), the latter form of actions and practices often takes place in 'in-between' or 'back-door' spaces that are not always evident. Such forms of 'everyday politics' may include strategies that people devise in order to create 'room for manoeuvre' in struggles over resources or to seek out alternative development pathways. Following Ann Swidler, strategies can thereby be understood as "persistent ways of ordering action over time" (1986:273).

In my research, I have actively sought to document how people respond to, cope with and shape change in their everyday lives in relation to land degradation and other stressors, particularly in the form of collective struggles. As suggested by Yaffa Truelove (2011) this may be one form of 'creative navigation' to secure livelihoods. Collective action can here be defined as "voluntary action taken by a group to achieve common interests" (Meinzen-Dick and Di Gregorio 2004:2). In the context of smallholder farming, such action may take various forms and occur at various scales, such as informal support networks between neighbours, self-help groups at the community level, and formal cooperatives (Pretty and Ward 2001, Baden 2013). While collective action through a clearly defined group is often more recognizable, and arguably most likely to contribute long-enduring impacts (Ostrom 1990), it may in practice also take more informal, fluid and flexible forms. Informal forms of collective action have been less studied than for example agricultural cooperatives and local organisation managing

particular resources, but may be more responsive to the differentiated and shifting needs of those involved (Pretty and Ward 2001, Pandolfelli, Meinzen-Dick et al. 2008). As Bina Agarwal suggests, social networks for informal cooperation are also "important sources of solidarity for organized collective action" (Agarwal 2000:293).

Collective action in the context of rural livelihoods has received increased attention among scholars studying social-environmental interactions. Much of this literature has focused on common property resources. Often it draws on economic analyses and models to analyse individual incentives to participate in collective action and human behaviour in resource dilemmas (Agrawal 2003, Cleaver 2007, Ostrom 2010). I have found this literature to be less relevant for exploring how smallholder farmers engage in collective action, which generally is not directly tied to the management of one particular (common pool) resource but serves more as an everyday strategy to cope with challenges and secure livelihoods through cooperation. Moreover, while much of the theoretical and empirical literature focuses on institutions for collective action (Pretty and Ward 2001, Meinzen-Dick, DiGregorio et al. 2004), I have explored the *processes* of collective action. As outlined in more detail in Paper II, we propose that the concept of 'communities of practice' offers a fruitful framework for doing so. Communities of practice are "groups of people who share a concern, a set of problems or a passion about a topic, and who deepen their knowledge and expertise in this area by interaction on an ongoing basis" (Wenger 1998:4). Centred on notions of shared meaning, trust and reciprocity and social learning, the framework emphasizes the dynamic nature of collective action and allows for exploring the social processes around which groups for collective action are formed, sustained and developed over time. While group approaches have long been promoted in rural development and natural resource management, surprisingly little research attention has been given to these important aspects, as pointed out by Ruth Meinzen-Dick et al. (2004).

Drawing on the concept of communities of practice, we explore how smallholder farmers organise in groups to pool resources, share risks and plan ahead (in Paper II). We argue that such strategies have offered women, in particular, room to manoeuvre to respond to change in an increasingly resource-constrained environment shaped by multiple stressors. In Paper IV, I also document ways in which collective action among farmers serves as an important arena for social change and negotiation of social taboos which may otherwise limit the acceptance and diffusion of urine fertilizer as an effective soil management practice. My research thereby contributes to the growing body of empirical evidence that network formation and collective action may play an important, and potentially growing, role for improving smallholder livelihoods by improving access to critical resources such as land, labour and information while also serving as a 'safety net' that strengthens members' capacity to cope with various shocks and crises, thus providing opportunities otherwise not available (e.g. Wangari, Thomas-Slayter et al. 1996, Pretty and Ward 2001, Pandolfelli, Meinzen-Dick et al. 2008,

Markelova, Meinzen-Dick et al. 2009, Shiferaw, Okello et al. 2009, Fischer and Qaim 2012, Baden 2013).

At the same time, it should be emphasised that people's capacity to exercise strategic agency is shaped and constrained by social, economic and political processes at various scales (Lister 2004, Brown and Westaway 2011). In Paper III, I argue that a set of structural barriers, including persistent poverty, the lack of rural development support and environmental stressors, implies inherent limitations to the type of change that can be achieved through self-organisation at the local level. Moreover, I argue that the micro-politics within communities are critical for understanding the social dynamics of collective action, particularly regarding gendered inequalities. More specifically, community engagement often falls to women's lot due to gendered norms and division of labour. Uncritical promotion of collective action as a strategy to support rural development may therefore risk reinforcing relations of inequality and marginalization. As called for by Caroline Moser (2003:34), my research is thereby an attempt both to give recognition to the gendered aspects of collective action and to problematize it as a development strategy. These perspectives are important to keep in mind in times when group approaches are increasingly espoused in agricultural development policy and practice (see Paper III).

Co-production of knowledge: attempts to bridge divides

Over the last decade, political ecology scholars have advocated not only critical analysis of social and environmental change, but also a more solutions-oriented research agenda (Robbins 2012). In such 'practical political ecology' (Rocheleau 2008) or 'engaged anthropology' (Kottak 1999) co-production of knowledge between academic and non-academic communities in the search for strategies and solutions towards sustainability plays a pivotal role. Indeed, some scholars insist that this type of engagement is part and parcel of the methodological commitment of political ecology (Paulson and Gezon 2004). This implies a movement towards research "*with* and *for* rather than only *about* social movements and people-in-place" as noted by Dianne Rocheleau (2008:724).

Transdisciplinary research, as a mode of integrating knowledge from science and society to achieve a more sustainable world, has been a core aspiration of sustainability science since its inception (Kates, Clark et al. 2001). Increasingly, I have come to embrace this ambition of linking research to action. More specifically it inspired me to explore how problem-driven, collaborative inquiry could contribute to knowledge generation with some type of *transformative* potential, most importantly in terms of positive change for those with whom I did research. In this section, I will expand on this aspiration and reflect on the crucial role that participatory research plays in development of locally anchored solutions to soil fertility problems in smallholder agriculture.

Strengthening sustainability through transdisciplinary research

In sustainability science it is a fundamental assumption that many sustainability challenges are 'wicked problems': persistent, complex, closely interrelated to other societal predicaments and involving several different scales, actors and contested social values (Rotmans 2005). Agricultural and resource management problems are typical examples (Thompson and Scoones 2009) that cannot be interpreted, analysed or tackled in isolation (Kates, Clark et al. 2001, Cash, Clark et al. 2003, Ostrom 2007, Miller 2013). This calls for transdisciplinarity, which in the context of sustainability science can be understood as:

> a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge (Lang, Wiek et al. 2012:26f).

In the context of agricultural science and innovation, strong disciplinary orientation and lack of dialogue between science and society have often resulted in failures to recognise this complexity. The prevailing knowledge-action gaps are particularly acute in efforts to reduce hunger and poverty, and especially so in sub-Saharan Africa where conventional approaches to agricultural development have often failed to reach the majority of farmers (Kristjanson, Reid et al. 2009, Leach, Scoones et al. 2010). The increasing influence of participatory alternatives, formulated in reaction to the failures of research carried out in isolation from farmers' realities, has meant a gradual shift in thinking (Sumberg and Thompson 2012). Also in the international development community there is a growing recognition that the achievements of development and sustainability goals have largely failed despite significant scientific and technological advancements. The strong message from the International Assessment of Agricultural Science and Technology report (IAASTD 2009) was that the prevailing model for knowledge generation, technology development and innovation needs serious revision. Participatory collaboration with farmers and other actors is seen as pivotal.

However, these insights have so far only slowly been translated into policy and practice, where conventional, top-down, technology transfer approaches remain dominant (Röling 2009, Sanginga, Waters-Bayer et al. 2009, Hauser, Chowdhury et al. 2010). As discussed earlier, the case of soil fertility management is no exception because the one-sided focus on technological aspects often fails to recognize the broader socio-economic and institutional conditions that determine farmers' abilities to adopt technologies and make long-term investments in their soils (Scoones 2001). To illustrate the prevailing notion that technologies are generated by research institutions and then diffused among farmers, I refer to a well-known soil scientist at the National Agricultural Research Organisation in Uganda whom I interviewed:

> As natural scientists we are wondering *why* farmers are not taking up the technologies they have tested. You hear good stories from farmers praising the technology, but why is there no adoption?! I think the socio-scientists will assist us in *finding the missing link* (Field data 2010).

This quote illustrates the tendency to view technology adoption in farming as an isolated activity and to reduce the details, complexity and diversity of soil management to a set of manageable generalisations and static facts. However, the quote also shows a frustration with standardised solutions that are ill-suited to farmers' realities. It hints at a growing realisation of the need for a fundamentally different approach to the development of solutions that are actually taken up by farmers. From the vast array of technology adoption studies in the context of smallholder farming we can draw the general lesson that adoption of new technologies and practices can only be expected to take root if farmers consider them to be appropriate and consistent with their context-specific conditions (Röling 2009, Shiferaw, Okello et al. 2009). Rather than trying to look for 'the missing link', as suggested by the soil scientist, this inspired me to engage in research that could generate practical knowledge that seems relevant to those involved (Reason and Bradbury 2008). This effort is hence a contribution to a more practical political ecology while taking seriously the goal of sustainability science to combine critical and solutions-oriented research (Jerneck and Olsson 2011).

Although co-production of knowledge linked to action and social learning is a core theme in sustainability science, the question of how this can be pursued in practice remains a critical challenge (Kates, Clark et al. 2001, Miller, Wiek et al. 2013). Social learning can here be understood as learning that occurs through social interaction and that creates "a change in understanding that goes beyond the individual level to become situated within wider social units" (Reed, Evely et al. 2010:n.p.). For the purpose of bridging the divide between theory and practice, my research contributes one example of how collaborative inquiry can be employed in order to guide pathways towards sustainability. More specifically, I demonstrate how participatory action research can be designed to envision, implement and evaluate a locally anchored solution to soil fertility problems, namely the use of locally produced human urine as a fertilizer in crop production (Paper IV).

Action research as a tool for practical political ecology

Action research has grown out of a range of research fields and is best described as a strategy or an 'orientation to inquiry' (Reason and Bradbury 2008). Since Kurt Lewin (1946) outlined his vision of the scientific and social value of working with practitioners to collaboratively analyse and resolve social problems, action research has been applied to a wide array of issues and settings. While there are numerous versions of action research, the underlying and guiding principle is to generate knowledge that is both

'valid and vital' to the well-being of individuals and communities involved (Brydon-Miller, Greenwood et al. 2003). One of many definitions states that:

> [a]ction research aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. Thus, there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process (Gilmore, Krantz et al. 1986:161).

The goal is actively to involve participants in all stages of a research process; from defining the focus and goal of research to data collection, analysis and interpretation of findings (Herr and Anderson 2005, Reason and Bradbury 2008, McNiff and Whitehead 2010). The incorporation of values and criteria from both scientific and non-scientific actors is meant to ensure the 'salience, credibility and legitimacy' of the knowledge produced (Cash, Clark et al. 2003).

Collaborative technology experimentation is one particular way of doing this type of research (Misiko 2009, Ramisch 2012). As discussed and demonstrated in Paper IV, such action-oriented research can produce practical outcomes that are highly relevant and applicable in the local context. From the perspective of social learning, the urine fertilizer experiment also demonstrates that the process of inquiry in itself is equally important as its practical outcomes. This illustrates how transdisciplinarity in the context of sustainability science can be "both a tool and a project" (Max-Neef 2005:12). While the experimentation process was initiated from a 'real world problem' and aimed to explore options for solving this problems through collaborative inquiry, the goal was also to study the process of change itself and to contribute to the understanding of the type of approaches and methods that can enable such change (Lang, Wiek et al. 2012).

Action research involving farmers thereby offers a fundamentally different and dynamic approach to agricultural development compared to the conventional transfer-of-technology model. Instead of portraying farmers as passive victims of environmental change, as is often witnessed in debates on land degradation (Paper I), this research highlights farmers' creative strategies to deal with challenges, including a rich repertoire of ideas for how proven technologies could be further advanced and disseminated. Moreover, the collaborative project that we performed together created a sense of pride and local ownership of the research process. As one of the participating women expressed it: *"There is science now even in agriculture!"*. This confidence was illustrated also by farmers' readiness to share their knowledge with fellow farmers and their continued experimentation on other crops. Action-oriented research may thereby not only generate knowledge that fits with local circumstances, but cay also motivate farmers to try out new strategies to adapt to changing conditions.

To use the words of Diane Rocheleau, action research thereby offers "one way to harness practical political ecology, and to demonstrate that many other worlds are possible and practical" (Rocheleau 2008, 723). In response to the repeated concerns that political ecology is not 'ecological' enough (Vayda and Walters 1999, Peterson 2000, Walker 2005), a more practically oriented political ecology can be an attempt to strengthen its ecological elements. Transdisciplinary research can indeed motivate also social scientists to engage with the biophysical realities of environmental problems and to get our hands into the soil.

3. Rooting knowledge in science and society

As discussed in the previous chapter, smallholder farmers' land use and soil management practices are influenced by the complex interactions of environmental, social, cultural, economic and political factors. Whereas dominant narratives tend to overlook some of this complexity, I seek to explore how in-depth, place-based knowledge generation based on interaction with farmers can develop a more nuanced and integrated understanding of social and environmental change. As suggested by Ritu Verma (2001:33), such an approach may offer an empirical and analytical opportunity of "working against generalisations". The research took place mainly in Paya sub-county[1] in Tororo district in south-eastern Uganda. Researchers and organisations have repeatedly drawn attention to the severe land degradation and high land pressure in this highland region (cf. Pender, Place et al. 2006, GoU 2010a). My first experience in Tororo was as a master student in human ecology in 2008, when I conducted fieldwork on smallholders' land management. In connection with that valuable experience I developed a social network and a deep appreciation for the place and the people I met. This dissertation thesis project has built further on that experience.

My own role throughout in the research process can be described as a gradual change from a more distant and detached position to an ambition actively to combine critical analysis and solutions-oriented research. As the research evolved, it also became increasingly clear that local land users are not only best placed to define and analyse their problems, but that their involvement in formulating and implementing solutions is crucial if such measures are to be feasible, viable and rooted in local realities. My growing interest in the effort to co-produce knowledge with some kind of transformative potential thus led me into action research. In this process, I have become increasingly convinced that methodological pluralism and transdisciplinary approaches are integral to political ecology. In this chapter, I will describe and reflect on methodological choices and considerations relating to how I constructed, analysed and interpreted the empirical material.

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[1] A sub-county is the lowest administrative unit in Uganda. Paya has a population of about 38.000 inhabitants (GoU 2010).

Methodological points of departure

For understanding farmers' strategies and livelihoods in a way that integrates both social and environmental dimensions, I employ an interdisciplinary and reflexive approach to enquiry that draws on empirical data from multiple sources. I mostly use a qualitative ethnographic strategy that embraces participatory inquiry, which fits the methodological considerations commonly raised in political ecology (Paulson and Gezon 2004, Rocheleau 2008). My research is interpretive and the goal is to explore the research topic in an empirically grounded and open-ended way (Bryman 2008, Ragin and Amoroso 2011). I strive to understand smallholder farmers' livelihood conditions, everyday strategies and complex realities from their distinctive points of view and frames of meaning. It is in the analysis of the details of people's accounts and the messiness of specifics that it is possible to construct an in-depth understanding of social and cultural systems and processes of continuity and change (Bryman 2008, Flick 2009).

Influenced by participatory research approaches, my guiding principle has been actively to involve stakeholders in the research process by inviting them to express their perspectives, to share their ideas with each other and with me and to reflect upon their own realities. This not only facilitates the exploration of the 'everydayness' of smallholder farming and land management, but may also increase the relevance of research to those involved. In the best case it may create a sense of local ownership over knowledge production and potentially instigate a degree of social learning and practical action (Chambers 1997, Mikkelsen 2005, McNiff and Whitehead 2010). This, again, is an explicit ambition of sustainability science (Lang, Wiek et al. 2012). Throughout the research process, I have therefore actively sought to recognize and build on farmers' agency. Among other things, my ambition is to bring out farmers' own words in order to 'give voice' to their differentiated experiences, perceptions and strategies, and to make those who have participated in and influenced the research process more visible (cf. Ragin and Amoroso 2011).

Stressing the perspectives of the research participants, *emic*, does not mean that I suggest the possibility of a 'psychological transference' (Kuper 1996), a key notion in classic anthropology of relating to the research subjects as 'us' rather than 'them'. A researcher is, of course, not a free-floating subject who can step in and out of her own frames of meaning and act as a neutral carrier and intermediary of another subject's reality and perspectives. As emphasised by Donna Haraway (1988) knowledge is influenced by the positionality of the knower and therefore always situated. This perspective implies that the world can never be observed as detached and as it 'really is' but only understood through partial perspectives. This posits that the researcher's own positionality, values and frames of meaning are inherent in all phases of the research process, thus

influencing the final representation and outcomes of the research (Ragin and Amoroso 2011).

This underlines the importance of critical reflexivity or 'self-critical epistemological awareness' (Chambers 1997), the goal of which is to make the research process more transparent and, in so doing, to emphasise that meaning does not exist in isolation. I therefore continuously need to reflect critically on how my own attitudes, values and situatedness as a white, relatively wealthy and educated woman from Sweden, influence my observations, interaction and questions I asked or not asked, as well as how I interpret and construct the reality of others.

I should also point out that the emphasis on context-specificity in knowledge production does not mean that I perceive the study setting as isolated and unique and that findings from this research are irrelevant beyond this specific setting. On the contrary, and as illustrated in the next chapter, the situation for smallholders in Tororo district in many ways reflects the generally dire conditions of rural Uganda and sub-Saharan Africa at large, suggesting that insights from this study may be highly relevant for and possibly also transferable to different but similar settings and issues (Flyvbjerg 2002).

Combining methods in the field

My research builds on a qualitative research strategy involving observations, interviews, group discussions and collaborative technology experimentation. I have also taken the opportunity to include some quantitative methods, mainly in the form of a questionnaire survey. While this helped me to ascertain specific information and get a broad view of certain measurable conditions, the focus on qualitative methods has proven invaluable to my research, particularly for emphasising subjective viewpoints and therefore enabling an in-depth understanding of the nuances, contradictions and complexities in the differentiated ways people experience, interpret and act upon their realities. My use of mixed methods to construct and combine various types of empirical data helped me to create a more detailed and comprehensive representation of rural landscapes and social worlds through integration of perspectives, cross-comparison of findings and exploration of inconsistencies and tensions across the material (Ragin and Amoroso 2011, Creswell 2013). Throughout the research process, and in relation to my overall knowledge and analytical frames, I analysed the empirical data in repeated cycles of comparison and adjustment, thereby refining my understandings and emerging representations of reality in an iterative process (Ragin and Amoroso 2011).

During four fieldwork periods in March 2010 to October 2012, I conducted a questionnaire survey including 100 household interviews, individual interviews with

45 farmers and 25 key informants, 27 focus group discussions in combination with various visual exercises, as well as a collaborative experiment on the use of urine as a crop fertilizer involving seven farmer groups. The combination of methods employed during the various fieldwork periods are summarized in Table 1, and discussed in more detail below. This rather extensive fieldwork process obviously yielded much more material than I could analyse in detail. As my research developed over time, some of it turned out to be of less importance. Yet in one way or another, all methods contributed to my overall understanding of the 'everydayness' of soils and farmers' strategies in this specific setting.

Table 1. Combination of methods for data construction during the fieldwork periods.

Field work	*Tools, methods and techniques related to themes*
March-April 2010 *7 weeks*	Questionnaire survey (100 households) on livelihoods, agricultural systems, land holding, access to rural services and social organisation Individual farmer interviews with narrative walks on land use, farming practices and rural landscapes (9) Focus group discussion on land management, farming activities, food security and gender issues (4) Focus group discussions with women on land and labour, household decision-making, widowhood and collective action (2) Key-informant interviews on land management, agricultural policy and extension, environmental change, NGO activities (9)
Feb-March 2011 *6 weeks*	Environmental history interviews with elderly farmers (6) Key-informant interviews on agricultural and development policy, gender issues, trade and cooperatives (8) Focus group discussions on collective action and options to improve soil fertility management (7) Initiation on collaborative experiment on urine fertilizer: training workshops, experiment design, plot measuring (7 groups)
July 2011 *2 weeks*	Evaluation of urine fertilizer experiments – observation and group discussions (7)
Sept-Oct 2010 *5 weeks*	Individual farmer interviews on collective action and urine fertilizer (30) Focus group discussions on collective action (7) Key-informant interviews on cooperatives, agricultural policy, rural services, extension, gender, urine fertilizer (8)

Observations and informal conversations

Observations of all kinds, including self-observation, are key to ethnographic research in that they permit a deeper understanding of the 'environing conditions' of the issues we study and the social relations at work (Becker 1998:54). For me, the possibility to live with a local family at one of the field sites was an invaluable opportunity to experience and participate in everyday life. The combined time spent in the field was sufficient to enable me to achieve a good understanding of the socio-economic context, local practices and conditions for smallholder agriculture, as well as to establish trust with those involved in the research. I timed my fieldwork to take place in different periods of the year in order to experience all seasons and phases in the farming cycle, including changing weather patterns, agricultural activities, and variations in farmers' exposure to stressors and vulnerabilities.

Staying in the village offered innumerable opportunities for informal conversations and interactions with women, men and children, which many times rendered more information and insights than the structured interviews. Direct observation and conversations in market centres and farm input stores also contributed to a better understanding of price levels, availability and supply. Staying within a walking or biking distance of most of the interviewees made it possible to return with follow-up questions or cross-check information if necessary. It also allowed me regularly to pass by the local government office to keep their staff informed about my activities and to get valuable inputs and perspectives on issues related to my work. Most importantly, spending much time 'in the field' and repeatedly returning was crucial to gain people's interest, confidence and trust. Without this foundation, the action-research element of the research would probably not have materialised. The collaborative experimentation deepened the trust which, in turn, enabled further conversations on potentially sensitive issues such as intra-household relations, experiences of social exclusion and group conflicts.

Because of the language divide, I worked with a research assistant during all parts of the fieldwork. In total, four assistants were involved – two women and two men who are all born and raised in the region. Working with assistants was invaluable to my work, not only because of the actual interpretation of language but also because they acted as 'informants in an ethnographic sense' (Bujra 2006:174). In various ways they facilitated my understanding of the local context, helped me to escape cultural blunders and opened doors to gain people's trust. Moreover, always working closely with someone familiar with the local setting offered innumerable occasions to ask questions, ventilate my thoughts and discuss insights from the research. However, being dependent upon interpreters also involves a number of challenges. It inevitably means that information is filtered through another subjective person. Particularly in focus group discussions the need for translation was at times challenging; since it was impossible to interpret everything that was said, it sometimes felt like "the rich flow of words was reduced to

a desert" (Bujra 2006:173). Moreover, the social position of research assistants may influence the dialogue and the way that participants expressed themselves. In this respect, it was a great advantage to work with four different assistants, who varied in age, gender and experience. Particularly in conversations with women, working with a female assistant made an important difference in the way the interviewees expressed themselves and the topics they chose to bring up.

I mostly conducted interviews with farmers in their homes, which added another level of understanding of their livelihood conditions and everyday realities. Before interviews started, I always made sure to explain the purpose of my research to the interviewees and how the provided information and my following analysis would be used. I was careful in emphasising that I was not associated with the government or any development organisation. I asked for consent and stressed that they at any point could decide to end the interview. In order to ensure the interviewees' anonymity, all names have been changed or omitted throughout the thesis. All questions were asked in English and translated into Dhopadhola. While this prolonged the interview process, it also allowed me space to be more attentive to the surroundings and the interviewees' body language, as well as enabling me to take extensive field notes. In addition to note-taking, nearly all interviews were audio recorded. Notes jotted in the margins of my notebook and the sound of playing children, crowing roosters and curious family members in the audio files have many times helped me to bring back memories of specific situations, conversations and environments, thus adding another layer to my under-standing – also in retrospect and when 'out of field'. In addition to the field notes, I also kept a personal journal to reflect on the research process and my decisions, dilemmas, and feelings along its way.

Repeated occasions of participant observations in farmer group meetings and various group activities also played an important role in my understanding of the local context. Although the Dhopadhola I managed to learn only allowed me to pick up a few words here and there, such occasions were valuable for attaining a better understanding of group dynamics: who speaks and who stays quiet, how is work divided and by whom? Giving some minor assistance in tasks such as weeding, digging and harvesting added another dimension of my understanding and a deep sense of respect for the hard work and long hours of women in particular in their daily work on the land. Most importantly, the collaborative experimentation offered valuable entry points for in-depth, more concrete insights into issues such as the organisation of farming activities, local knowledge and social dynamics in the farmer groups.

Household survey on measurable aspects

In 2010, during my first field trip, I conducted a questionnaire survey including 100 farmer households for the purpose of obtaining specific information on livelihood conditions, agricultural production, landholding patterns, land management practices, access to rural services and social organisation. My intention was partly to follow-up on a previous survey that I had carried out in 2008 in order to explore possible changes in farmers' land management strategies. I also wanted to examine other aspects in more detail, particularly farmers' membership in community groups and the impact of such groups on their livelihoods. The survey was therefore conducted among the same sample as in 2008, which for logistical reasons was limited to Paya sub-county where I was staying. Within Paya, I randomly selected three villages: Sere A, Sere C and Patewo. Based on list of all the households in these villages, which was accessed through the 2002 National Population Census, I used a random sampling strategy (Bryman 2008) to select the households. One third of these were specified to be female-headed households, so as to be able to analyse gender-related differences in resource access, livelihood strategies and group engagement. Only de jure female-headed households, that is, households headed by widowed, divorced or unmarried women, were included as only these were included in the household list.

To enable modification and clarification of the questionnaire, I conducted a pilot survey among a few households in another village. With the help of a local field assistant I personally conducted all interviews, which generally lasted about one hour. In the few cases where a particular person interviewed in 2008 was for various reasons no longer available, he or she was replaced by another member of the same household. In most cases, we carried out the interviews in the homes of the interviewees. This not only afforded me a valuable opportunity to observe the surroundings and cross-check some of the information given, but a setting in which the interviewee feel comfortable is also likely to facilitate the conversation (Kvale 1996).

Together with my pre-understanding of farmers' livelihoods and land management strategies from my previous research in the area, the household survey played an important role in providing more and specific information. Among other things, it enabled me to understand better the differences in resource access and sources of livelihood vulnerability within the sample, particularly related to household headship. The information from the survey also guided me in identifying themes for further exploration through individual interviews and focus group discussion, for instance in relation to the roles and functions of local farmer groups for collective action in relation to land management and livelihood security.

However, the survey turned out to play a less important role in research than anticipated and I mainly used it for descriptive purposes. One reason for this was that I conducted the survey very early in the research process, which meant that the

questions spanned a wide range of areas and were sometimes too unspecific or ambiguously formulated for the results to be meaningful. A further important limitation was that I focused on the household as the unit of analysis, which prevented me from analysing gender differences within households (cf. Quisumbing 2003). Moreover, although I included a number of open-ended questions, I increasingly felt that the format of a questionnaire had significant limitations in terms of minimal flexibility and control on the part of the interviewee. This often left me with an uncomfortable feeling of 'extracting' information rather than inviting the interviewee to share his or her experiences and knowledge, thus reproducing asymmetrical relations between 'the researcher' and 'the researched'. At times I also had reason to believe that people modified their answers to avoid feelings of shame or fear of coming across as uninformed or ignorant, for instance in relation to (non-)adoption of various farming practices, which opens up for concerns regarding the validity and reliability of the data.

Moreover, I found that the questionnaire format 'trapped' me in my own frames of understanding, entailing the risk that I missed important perspectives and that I would run into the problem of 'trying to measure the immeasurable' and/or 'measuring the irrelevant' (Mayoux 2006:119). To summarize, in my experience the use of questionnaire surveys is not unproblematic and requires a considerable level of pre-understanding of the specific context. Nevertheless, every now and then I have revisited survey data both for specific information and for describing and illuminating general livelihood patterns, agricultural systems and land management strategies.

Interviews with individual farmers

Individual interviews with farmers have been one of the most important methods for exploring the nuances and particularities of peoples' knowledge, experiences and viewpoints. In total, I carried out 45 semi-structured interviews with farmers during different phases of the research process, generally lasting between half an hour and two hours. Based on a list of themes and sub-themes rather than a fixed set of questions, the interviews were conducted more as open-ended conversations. Steinar Kvale (1996) describes this type of interview as 'a construction site of knowledge', based on the interaction between the interviewer and interviewee. Compared to the questionnaire interviews, I appreciated how conversations could develop more organically, leaving room for the interviewees to develop their responses and reactions and to bring up new ideas and thoughts. In this way, the interviews were important both for following up on themes in greater depth and for introducing me to new and potentially important issues. To facilitate the conversation and encourage people to express themselves in a way that suited them, I always emphasised that no answer is any better than others. In order to signal curiosity and to invite people to expand on their answers, I strived to ask questions of *how* rather than *why* (cf. Becker 1998). My field assistant's usual

remark that the interview situation was unlike interrogation and 'not like in school' usually helped to create a relaxed atmosphere. In the beginning, I was a bit hesitant to use the audio recorder since I feared it would make the interview situation less 'natural'. However, I soon realized that the small device did not interfere the dialogue.

During my first period of fieldwork, I carried out these individual interviews with nine farmers, five women and four men, focusing on land management issues. The interviewees were selected using purposive sampling and based on who happened to be available. I strived to ensure the inclusion of a diversity of voices and situations in terms of farm size, socio-economic status and household headship. The focus of the conversations was how the interviewees perceive, comment on and evaluate changes in land productivity, what type of individual and collective strategies they use to maintain and regenerate their soils and what key constraints and challenges they experience in doing so. Conversations were combined with 'narrative walks' (Jerneck and Olsson 2013) on interviewees' farms, which allowed me also to observe, photograph and ask specific questions about various farming practices and various actors' use of, access to and control over the resources that we observed together and spoke about during the walks. Many times such narrative walks also led me to issues of interest not mentioned by the interviewees themselves. In this way I learned more details about issues such as land tenure systems and heritage, gendered division of labour and differences in resource access, the growing importance of collective action through farmer groups, as well as crop pests and disease problems, and changing practices due to land pressure and increasing climate variability. If a certain practice captured my interest, farmers were often enthusiastic to explain and demonstrate it in their garden. Among other things, I witnessed different methods of digging the soil to prevent soil erosion, intercropping systems in vegetable gardens and the preparation of 'plant tea'—a liquid fertilizer based on various green leaves, chili and wood ash (see Paper IV).

During my second fieldwork period, I conducted additional interviews with six elderly farmers, two women and four men, in what can be described as an oral environmental history approach (Nightingale 2003). I identified interviewees with the help of my field assistant and a village chairperson. My aim was to obtain a better understanding of environmental, social, economic and political changes in the rural landscape in general, and in farming practices and land management strategies in particular. Remotely sensed images of the sub-county and specific villages printed from Google Earth usually amazed the interviewees and helped stimulate the conversation about continuity and change in the rural landscape in terms of land use, grazing systems, tree cover, soil management and farming practices from the perspective of people who have used the land over a long period of time. These interviews also provided important insights about the way in which livelihood conditions and farmers' collective strategies in relation to agricultural activities changed over time. While bearing in mind that memory is subject to revision and fragmentation and potentially prone to exaggeration, and that oral history therefore is also 'storytelling occasions' (Skinner 2012), such

accounts offered valuable perspectives on agro-ecological changes over time, embedded within people's personal experiences of broader social, economic and political change (cf. Rocheleau 1995, Nightingale 2003).

During the last fieldwork period, I conducted individual interviews with 30 additional farmers, 16 women and 14 men, including both farmer group members and non-members. The interviews revolved around two separate themes, since my purpose was two-fold: first, to explore collective action strategies among farmers in greater detail, focusing on functions and social composition of local farmer groups, their merits and limitations, as well as individual motives for (non-)membership (for Paper III), and secondly, to follow up on the urine fertilization experiment about one year after its completion (Paper IV). Specifically I asked experiment participants about their further use and modification of the practice and interviewed non-participants to explore some of the reactions and perceptions of the practice in the wider community. I identified volunteers for these interviews in association with farmer group meetings and used snowball sampling for non-participants.

Photo 1. Man showing his compost heap.

Photo 2. Elderly woman being interviewed.

Photo 3. Field assistant Frances Nyachwo assisting in interviewing a woman.

Key informant interviews

In total I conducted 25 semi-structured key informant interviews with key informants in Kampala and Tororo, including researchers, international development organisation staff and agricultural extension officers and field staff, as well as input traders, teachers and local leaders. For each interview, I prepared an interview guide to ensure that important areas were covered, but endeavoured to let the respondents develop their answers and bring up new ideas. These interviews served as a valuable opportunity to compare different perspectives, discuss my own understandings and obtain updated information about ongoing rural development programmes and initiatives. It also provided me with detailed information on land degradation processes and land management strategies, national agricultural policies, land tenure systems and rights, agricultural market structures and the specific conditions and history of the region. Finally, interviews that I conducted towards the end of the research process also gave me a chance to discuss and report back my research to key persons at district and sub-county levels. Besides taking detailed notes, I audio recoded the interviews, except in a few cases when the informants did not give their consent.

Focus group discussions with farmers

I also carried out a total of 27 focus group discussions, generally lasting two-three hours. For this I used purposive sampling in accordance with the topics of discussion (Bryman 2008) and most of the discussions took place in the three villages where I did the questionnaire survey. As pointed out in the literature, focus groups offer a conducive social setting for capturing attitudes and opinions among participants and for exploring specific topics in depth (Mikkelsen 2005). They are particularly useful for studying collective social action and 'ways of doing' which might be overlooked in individual interviews (Lloyd-Evans 2006). Such group discussions have been one of the most important methods for deepening my understanding of farmers' land-related challenges and their individual and collective considerations and strategies to deal with those. Moreover, the urine fertilizer experiment directly spawned from such group discussions.

Focus groups also served as a platform for various visual exercises and tools, such as mapping, ranking and diagramming, which have been useful throughout the research process. In most cases, I had planned and prepared these exercises, such as problem tree analysis of land degradation problems, soil and farm resource mapping, crop yield timelines, seasonal calendars and social support mapping (see Fig 2, 4 and 7 for examples of outcomes). Some instances of mapping and ranking also occurred spontaneously, for example when someone started to draw an illustration in the sand to illustrate her or his reasoning or when a discussion arose on how to rank the importance of factors contributing to a certain phenomenon. I always tried to be observant about such initiatives, make them more explicit and invite all participants in the discussion. I learned always to carry flip chart papers and marker pens to facilitate this. These exercises were valuable not only in terms of their concrete outcomes but also for the way in which they tended to spur discussion and stimulated participants to reflect on and analyse their realities. The exercises also served as a strategy to induce active participation by people who were otherwise less outspoken than others and to identify visually issues of consensus and disagreement. It thereby offered a non-verbal way of communication, which many times felt like a relief since all discussions were interpreted through my field assistant. During the focus group discussions I took detailed notes which I later went through together with the field assistant and, when necessary, compared and complemented with help of the audio recordings.

It should be pointed out that groups can be subject to peer pressure and that impressions of consensus might therefore be misguided (Lloyd-Evans 2006). Although I always encouraged the participants to speak freely and stressed that agreement was not the goal, it was sometimes challenging to get everyone involved and active. Especially in mixed groups, patterns of male dominance were sometimes evident, which means that important perspectives and tensions might have been silenced. The large number of women-dominated group discussions hopefully compensates for this.

During the first fieldwork trip, I carried out four focus group discussions with women and men from different socio-economic groups, which were selected with the assistance of a village chairman. Each focus group included 6-11 participants and the themes discussed revolved around land use and farming practices in a broader livelihood context such as resource access, food security and health, land tenure, rural services and climate impacts. I also conducted two women-only focus groups, centred on issues of gendered division of labour and responsibilities, decision-making and control over incomes and resources within households, land rights, widowhood, and the role of informal social support networks and community groups. Soil mapping is one example of an exercise that I invited farmers to participate in, as exemplified in Fig. 2. Such maps served as good starting points for engaged conversations on visible and invisible aspects of soil degradation and interlinked problems, current management practices, as well as potential strategies for soil improvement. Photo 4 shows the processes of seasonal calendar mapping in another group.

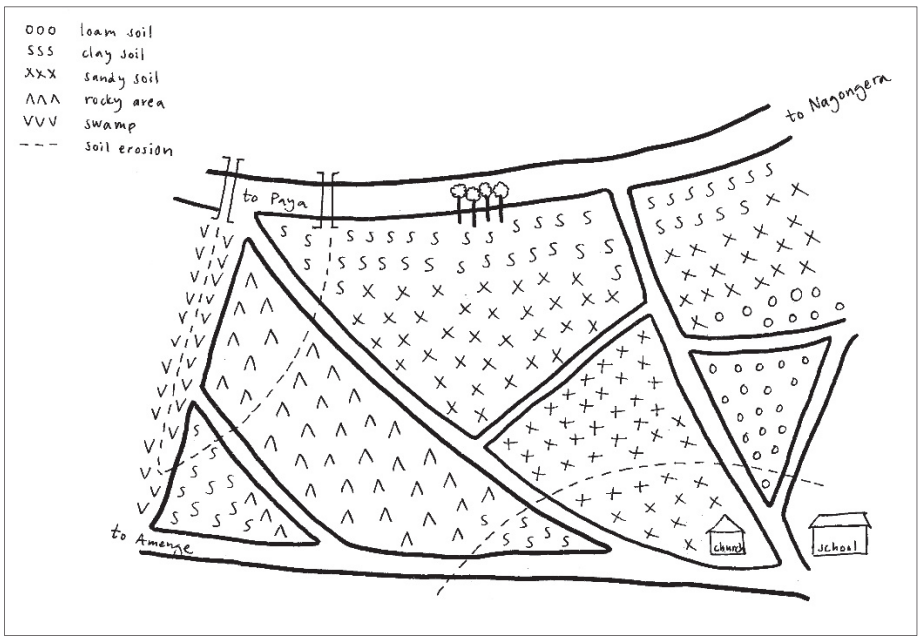


Figure 2. Participatory soil mapping (2010)

Photo 4. Seasonal calendar mapping

In the second fieldwork period, I focused on the role of farmers' collective strategies in the context of rural livelihoods and land management. In a series of seven group discussions, members from local farmer groups were invited to participate. With the assistance of a village chairperson, these groups were strategically sampled according to the following criteria: groups should receive no external funding, be self-initiated and involved in multiple activities for more than one year. In each group discussion, 7-15 members, mainly but not exclusively women, took part. Themes for discussion included group functions and organisational structure, benefits and drawbacks of collective engagement and the impact of collective action on livelihood security. Inspired by the on-going activities and technology experimentation among the groups, I also initiated discussions on potential solutions to the soil fertility problems faced by many farmers. These solutions-oriented discussions triggered what later turned into a collaborative experimentation process on using human urine as a crop fertilizer, including all of these seven groups. During the third short period of fieldwork, I conducted another round of group discussions in each of the farmer groups to evaluate the urine fertilizer as a practice, as well as to reflect on and analyse the learning process itself.

In the last fieldwork in 2012, I returned to the same seven groups for a final round of discussions in order to deepen my understanding of farmers' collective strategies in the pursuit of securing livelihoods. This time the discussions centred on the social composition and dynamics of groups, organisational structure and membership rules, perceived challenges and limitations of collective action and experienced attitudes to group engagement.

Collaborative technology experimentation through action research

The action research element of the research was largely unplanned and developed as a result of my interaction with farmers. As previously mentioned, solution-oriented conversations emanated from group discussions on how soil-related problems are experienced, understood and tackled by farmers, individually and collectively. By combining sociological imaginations (Mills 1959) with technological imagination (Rocheleau 2008) we jointly identified potential options for improving soil fertility management. While various options were brought up and discussed, the use of urine fertilizer was a practice that repeatedly figured in our conversations. I had previously asked farmers about their use and knowledge of the practice and got numerous questions in return, which in most cases I was unable to answer. This gradually stimulated our mutual curiosity to learn more about the practice and evaluate it in this particular setting. Action research can be describes as an iterative, cyclical process comprising one or several cycles of planning, action and reflection upon action. The various phases in the urine fertilizer experiment – problem diagnosis, action planning, implementation, evaluation and learning specification – are summarised in Fig. 3 and discussed in detail in Paper IV. The text boxes indicate the key activities that took place in each step of the action research cycle.

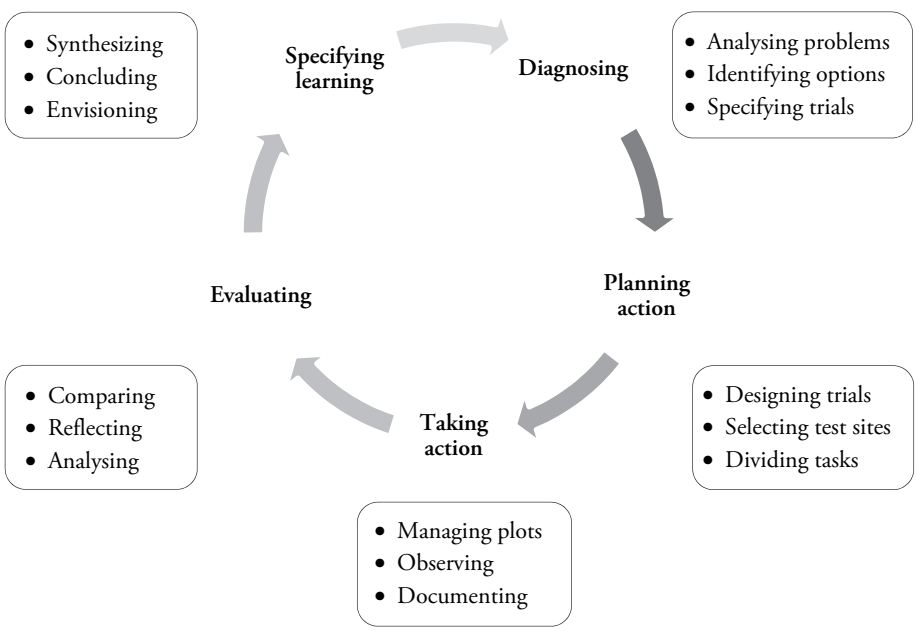


Figure 3. Visualizing the action research cycle. Source: adapted from Susman (1983) and based on fieldwork (2010-2012).

While the action research experience was an exciting and highly rewarding experience it also posed a range of challenges. To start with, engaging in action research requires researchers to take on multiple roles. While being a 'reflective scientist', I also needed to be an 'intermediary' in order to balance and integrate different perspectives and interests, as well as a 'facilitator' of the joint learning process (cf. Pohl, Rist et al. 2010). Navigating in the messiness of these roles and in the partly different goals between academic and non-academic communities was sometimes challenging but at the same time a learning experience in itself. Dealing with the dynamic nature of action research, and the range of uncertainties it presents, also posed important challenges. I was at times concerned that the outcomes of the experiment would not fulfil the expectations among the participants. To deal with this I repeatedly stressed that the experiment was a learning process also for me and that I also did not know how the results would turn out. However, although "designing the plane while flying it" (Herr and Anderson 2005:69 cited by Smith, Bratini et al. 2010:409) makes for an exciting research experience, it undoubtedly raises ethical considerations and responsibilities, particularly when, in a context of harsh poverty, people invest considerable time, land and resources in testing a new farming practice that *might* bring benefits.

In order to create a foundation for a collaborative relationship with the farmer groups I also had to understand the social dynamics within the groups and gain their trust. As pointed out earlier, the value of my repeated engagement with the same groups over a longer period of time can hardly be overstated in making this possible. Finally, in order for action research to be meaningful for those involved, it requires sustained engagement through the whole cycle. The fact that I was not in Uganda during the largest part of the growing season meant that I did not have full insight in how the experiment developed. However, one farmer took on the role of 'experiment facilitator', meaning that he was involved in all phases of the process and available to assist the groups during the implementation and management of the experiment, as well as when the final yields were weighed. This greatly helped me to maintain the contact with the groups and stay informed about the process. That the groups implemented, managed and documented the experiment even in my absence can in itself be seen as a sign that the experiment grew out of a collaborative process, motivated by farmers' curiosity and engagement.

Based on this experience, I identify three aspects that contributed to the project's positive outcomes and the sense of local ownership that it created. These 'lessons' could be relevant also in other settings and it is therefore meaningful to briefly reflect on them. A first factor that appears to have been important is that I worked with already existing groups and therefore could build on activities that farmers already were engaged in, that is, joint experimentation on farming practices. This greatly facilitated both the dialogue and action implementation. Secondly, a sense of local ownership could develop only by maintaining a high degree of flexibility and sensitivity to participants' own priorities throughout the process, even in cases where these priorities

conflicted with my own or with what I believed most suitable. Thirdly, because the use of urine as a fertilizer may be culturally sensitive, gaining the support of local leaders and maintaining openness about the experiment, for instance by selecting test sites easily observable for other community members, proved important for minimising the risk of social stigmatisation for those involved.

Photo 5. Measuring test plots for the urine fertilizer experiment.

Photo 6. One of the farmer groups by the experimentation site.

Analysis and interpretation of the material

The combination of methods that I employed during the fieldwork resulted in a rich empirical material in the form of survey data, field notes, audio files, visual outputs of various ranking and mapping exercises, photographs and data from the collaborative experiment process. My analysis and interpretation of this material did not start at the final stages of the research but took place in repeated and overlapping cycles as I moved back and forth between the empirical material and my theoretical and conceptual frames in an iterative process (Ragin and Amoroso 2011). During the fieldwork periods, my daily habit of writing up my notes during the evening or the following morning helped me to see when answers, concepts and themes had been repeated across interviews and group discussions to such an extent that I felt the need to open up new paths of inquiry, guided by issues that emerged from the material. It also helped me to summarize my impressions and make lists of key issues and themes that I needed to explore further. Multiple fieldwork periods allowed for repeated stages of analysis and interpretation of the empirical material, as well as for further reflection and development of ideas, themes and concepts. As regards the qualitative data from the household survey, I mainly carried out descriptive analyses which I combined with interviews and groups discussions at different stages to interpret the information.

Between the fieldwork periods, several stages of 'bringing order' and 'making meaning' of the empirical material took place. I first organised the material into key themes, categories and patterns, and then compared and contrasted such themes, looking for relationships, linkages, contradictions and possible interpretations by moving back and forth between the material and theory in a process of analytical induction (Ragin and Amoroso 2011, Rossman and Rallis 2012). Since I made detailed notes during interviews and focus group discussions, I generally did not transcribe interviews in total. Rather, I used my notes to identify key words and salient themes and then turned to the audio files to revisit and transcribe selected parts that I found particularly relevant and important. I have often worked with these processes of analysis and interpretation in concrete, visual ways. For example, I clustered citations to identify recurrent themes, colour-coded such themes throughout the material, and made mind maps and problem trees to visualise links between the themes and their connections to my conceptual and theoretical frames. Such processes have been helpful both in identifying the overarching themes and conceptual frameworks for my research and in guiding the more detailed analysis and interpretation of the empirical material for each of the papers. As described by Karin Widerberg (2002), it is through the constant hermeneutic movement between the parts and the whole that we can build an overall understanding of the issues under study that is both deep and broad.

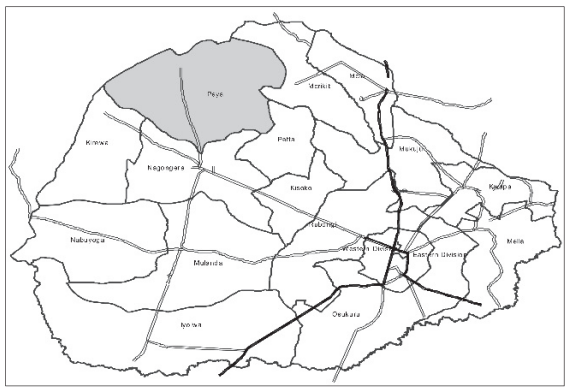
4. Setting the scene in Uganda

The 'everydayness' of soils in smallholder farming must be understood against the backdrop of farmers' general livelihood conditions and vulnerabilities situated in the wider context of environmental, socio-economic and political change. In this chapter, I will introduce the specific research setting in terms of smallholder livelihoods and farming systems in Tororo, farmers' perceptions of soil productivity problems and the contemporary agro-political scene in Uganda. As will be shown, the situation for smallholder farming in this setting largely reflects the generally dire conditions experienced by rural producers in many areas in sub-Saharan Africa. The analysis of farmers' livelihoods and farming systems is largely based on my household survey data in 2010, combined with in-depth interviews and group discussions, to outline how soil fertility problems are understood and experienced locally.

Smallholder livelihoods and farming systems in Tororo

Tororo district is located in the south-eastern part of Uganda, just along the border with Kenya and at a distance of about 200 kilometres from the capital city of Kampala (Map 1). Paya sub-county, where my research mainly took place, is situated in the north-western part of the district about 25 kilometres from Tororo town, which is the administrative and business centre (Map 2). The villages in Paya are situated along an unpaved, poorly maintained road and are connected to each other by a network of barely motorable paths. The distance to the nearest small town and trading centre, Nagongera, is 7-9 kilometres. The district is part of an ancient migration corridor and one of Uganda's most diverse regions in terms of ethnic groups. The Jopadhola are the largest group, followed by the Banyole and the Bagwere (Meinert 2009).

Map 1. Locating Tororo district in Uganda. Source: adapted from UN (2003).



Map 2. Locating Paya in Tororo district. Source: adapted from RCDF (2010).

The rural landscape in Tororo

As in most regions of Uganda, the rural landscape in Tororo is dominated by rain-fed, smallholder agriculture, which provides the livelihood basis for the absolute majority of the population, both in terms of food provision and cash income. The district belongs to the 'banana-millet-cotton' farming system and was previously considered to be of medium productivity (GoU 1997). Soils in the district are varied but dominated by reddish-brown sandy clay and loam soil types with generally low organic matter content and soil fertility (GoU 1997, Delve and Ramish 2006). Tororo is part of the East African highlands which is identified as a region where land degradation problems are particularly severe, contributing to low and declining agricultural productivity (Pender, Place et al. 2006, GoU 2010a). Although Tororo is a relatively flat area, high levels of soil erosion have been reported (GoU 1997, Delve and Ramish 2006).

The annual rainfall in the district ranges from about 1,100 to 1,700 mm per year (GoU 1997) and is distributed in a way that allows two cropping seasons; the long rains occur between March and June and the short rains between August and November. However, in interviews farmers recurrently report increasingly unpredictable rainy seasons and changing rainfall patterns, resulting in both intensified flooding and prolonged dry spells. Similar observations by farmers in the region have been reported in other research (Oxfam 2008, Osbahr, Dorward et al. 2011, Gabrielsson, Brogaard et al. 2012). Future climate variability and change in terms of increasing temperatures and changes in precipitation are projected to have major negative impact on numerous aspects of smallholder livelihoods in the region, including agricultural production, water availability, human health and food security. Such changes are thereby expected to present new challenges and exacerbate existing stressors and vulnerabilities affecting people that live in persistent poverty and depend on rain-fed agriculture (IPCC 2014).

Homesteads in Tororo are dispersed in the landscape and the region is one of the most densely populated in the country. Housing quality is generally poor but varies considerably among households – from traditional huts made of mud and wattle with grass-thatched roofs to iron-roofed brick houses. Households' access to safe water in Paya is relatively high (GoU 2010c) but sanitation facilities are generally poor and electrification is lacking in the villages. According to the most recent population census, the average population density in the district was about 330 inhabitants per km² in 2002, a number that was projected to increase to above 400 in 2012 (GoU 2006). The pressure on land in the district is high and nearly all arable land is under cultivation. Farm sizes vary but are typically very small and intensively cultivated. In fact, the average household in Paya consists of 6.5 members relying on 1.3 hectares of land. Expansion of cultivation into increasingly marginal areas in combination with land fragmentation due to division of the available land into ever-smaller plots, are widespread problems. As in many other areas of sub-Saharan Africa, land is thereby increasingly becoming a constraining factor of production. This implies that increases

in agricultural output must derive from intensification of production on existing land (Pretty, Toulmin et al. 2011).

Smallholder livelihoods and farming systems

Smallholder systems are complex and diverse in terms of livelihood strategies, intensity of agricultural production and capacity to cope with and adapt to changing circumstances and environments. A livelihood lens helps to illuminate the various ways in which people organize their lives, how they navigate change and what constraints they face in doing so. It recognizes poverty as a contextual and multidimensional phenomenon (Ellis 2000, Morton 2007, Thompson and Scoones 2009). What poverty may imply in this specific context is illustrated by how one young woman in Paya describes whom she regards as rich and whom, respectively, as poor:

> Those who are rich are those who have lots of crops and land of-- let me say-- more than two acres [0.8 hectares] and some livestock. A poor person normally rents land for cultivation, does not have enough to eat and does not have household utensils. It is one who has no money at all, one who digs for payment [casual farm labour], one who lacks education and one who has very many children (Amali Doreen).

As regards the specific farming systems in Paya, cassava is the most important crop grown for household consumption, followed by maize and millet. Farmers report that the relative importance of cassava has increased as a result of land degradation and climate variability due to its robustness and tolerance to drought and poor soils. The roots can be stored in the ground for a long time and are often kept as a 'resting crop' that can be harvested in times of hardship. The increased importance of cassava as a result of declining soil fertility has also been noted in other parts of the region (Fermont, Van Asten et al. 2008). Other major food crops grown by farmers include sorghum, sweet potato and groundnuts. Many households keep some poultry and goats while some also keep cattle, but the number of animals is generally low and has decreased drastically over time, mainly due to new types of diseases and as an adaption to land scarcity. Farming is predominantly done manually with basic tools which are often in rather poor condition. While some households have access to oxen and ploughs, land preparation is done by hand hoes in most farms. The use of purchased farm inputs is low and only three percent of households use inorganic fertilizer on their fields. Most households rely on local seed varieties which are saved from the previous season, exchanged with fellow farmers or bought from local farm input stores. In recent years, the use of improved seeds has increased for some crops, maize in particular, and is now used to various extent by around two thirds of households. A seasonal calendar indicating the rainy seasons, farming activities and periods of food sale and purchase in a typical year is illustrated in Fig 4, which is the outcome of a focus group discussion.

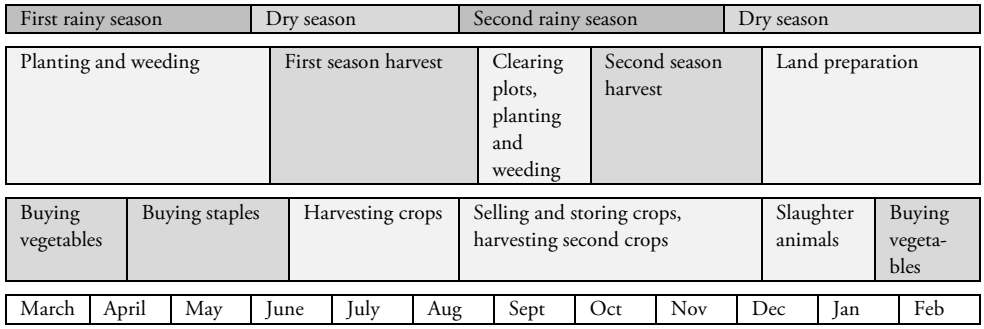


Fig 4. Participatory seasonal calendar mapping (Field data, 2010).

While smallholder households mainly rely on family labour, about one fourth of households also hired labour at some point during the most recent year. The ability to supplement family labour during particularly intensive periods in the farming cycle significantly enhances the agricultural opportunities and investments in land that are available to a household. This is especially true in a context of increasing climate variability which obstructs farmers' ability to plan ahead. As explained by one farmer:

> It is now very difficult to predict when the rain will come. If it starts early, land preparation is not always finished and then everybody gets too busy. Other times it is raining too much and we need to harvest quickly to prevent the crops from getting damaged. Then all labour is needed (Oboth Francis).

Typically it is young men who work as casual labour but increasingly also farmer groups dominated by women are providing labour for others as a source of income. As discussed in more detail in Paper II, labour pooling through such groups plays an increasingly important role for farmers, women in particular, who otherwise cannot afford to hire labour.

Gendered aspects of labour, land and well-being

Interviews with farmers in Paya illuminate the gendered aspects of labour division and resource access in agriculture, as discussed in Chapter 2. To exemplify, the disproportionate labour burden generally shouldered by women in both the productive and reproductive spheres (Quisumbing, Brown et al. 1995, FAO 2011a) is evident in focus group discussions where men and women were asked to list what they consider women's and men's respective responsibilities in daily activities. Views independently expressed by women and men are largely corresponding and summarized in Table 2. It should be emphasised that gender norms are not necessarily the same as gendered practices and neither norms nor practices are static but constantly negotiated (Doss 2001, Bergman Lodin, Paulson et al. 2012) and therefore contextual. Nevertheless, the

list reflects the fact that men tend to be responsible for the household economy while the largest burden of heavy, tedious and time-consuming daily work is shouldered by women (c.f. Moser 2003, Blackden and Wodon 2006).

Table 2. Farmers' notions of gendered division of work and responsibilities

Women's responsibilities	Men's responsibilities
Planting and sowing crops	Preparing the land
Digging and weeding	Planting and sowing crops
Bringing the crops from the field	Looking after the cattle
Looking after the goats	Selling crops
Collecting fuel wood	Buying food
Fetching water	Paying school fees and health care
Cooking	Constructing the house
Caring for children and elders	Securing the home
Washing clothes	Entertaining visitors
Sweeping the compound	
Engaging in community groups	

As regards access to land and other productive resources, gender inequalities remain significant. The median farm size among female-headed households is 0.8 hectares, which is half of that of male-headed households, and more than half of the women in this group rely on less than 0.5 hectares of land. While land tenure systems in Uganda are varying and overlapping, customary tenure remains predominant. This is also the case in Paya, as in the Eastern region at large. Customary tenure systems vary across regions and ethnic groups but in principle the allocation of land is administrated by kinship-based institution at the local level and land is held by the family unit. People thereby have rights to use land but they do not have land titles (Tripp 2004). The right to manage land is generally assigned to the head of the household, who in turn has the responsibility to ensure other family members' use right and that such rights are passed on to the next generation (Adoko, Akin et al. 2011, Munk Ravnborg, Bashaasha et al. 2013). As discussed in Chapter 2, women's access to land is thereby often dependent on their relationship to a male family member, meaning that the security of their land rights is often tenuous. Loss of land rights often implies social and economic deprivation, which in itself is a threat that keeps many women in a subordinate position in relation to their husbands and in-laws (Adoko, Akin et al. 2011).

In focus group discussions and interviews, women in Paya are generally outspoken about the discrimination against women in relation to land, which particularly puts widows and divorced women in vulnerable positions. Married women are also exposed to insecurity, partly due to the tradition of polygany; if a husband decides to marry a second wife, the land given to her is often taken from the first wife. As regards land transfers, the law stipulates that written consent is required from the wife/wives. However, not all women know about their rights or have the power to oppose their husbands (cf. Adoko, Akin et al. 2011). Moreover, women in Paya repeatedly state that

existing laws and regulations are frequently not respected and women's ability to claim their rights is often limited. As explained by one woman:

> According to the law, the wife gets 15 percent of the land if her husband dies and the rest should be equally shared among the children. If there are several wives, they should get 15 percent each. But this is actually not much practised and usually it is just the sons who get land. So actually, it does not matter how many laws we have if they are not being followed here (Nyandori Mariam).

Women also report numerous cases where "stubborn women" involved in land conflicts have been subject to crop theft and other forms of harassment. In the wake of growing land scarcity, there are signs that social tensions and conflicts around land issues have intensified both within families and communities in the area. This underlines the importance of recognizing not only the legal aspects of women's land rights but also the discrepancy between legal principles and what actually happens on the ground. Survey data indicate that 23 percent of female-headed households rely mainly on land under private tenure, compared to only eight percent of male-headed households. This suggests that women may need to find alternative ways to acquire land as they fail to access land through the customary tenure system. Interviews show that collective renting of land through farmer groups also plays an important role for women as an alternative way to access land.

Besides access to land and other basic needs such as food security, health, proper housing and cash income, key aspects of well-being as defined by women in group discussions largely focus on intra-household relations. This includes the ability to cooperate with their husbands and influence decisions in the household, particularly regarding priorities in farming and how to spend proceeds from crop sales, both from their own crops and gardens as well as from their husbands' fields. Other important aspects of well-being include husbands' willingness to contribute to household expenses such as for food, health care, school expenses, clothes, soap and paraffin, as well as their consent to participate in farmer groups and other types of community groups.

Vulnerability, diversification and livelihood complexity

Interviews and focus group discussions indicate that many farmers experience a dwindling capacity to sustain themselves through farming. This view is largely shared by local leaders, agricultural extension officers, and development workers in the district. Crop yields have gradually declined over time and are typically well below potential yields attained by experimental farms at research stations (cf. Pender, Place et al. 2006, Whyte and Kyaddondo 2006). Elderly farmers report that crop yields in the 1950s and 1960s were often more than fourfold those of today. In addition, post-harvest losses are high and most households lack proper storage facilities. This negative long-term trend

in agricultural productivity is one of the most important indications of deteriorating livelihood conditions in the area. Besides poor soil fertility and erratic rainfall, other factors such as land shortage, ill-health, low producer prices, lack of access to rural services and poor governmental support are identified by farmers in group discussions as the main drivers of the low agricultural productivity, food insecurity and persistent poverty in Paya. Although the Ugandan government has declared increased investment in agriculture as its key strategy in seeking poverty reduction (GoU 2000), farmers operate in an unfavourable environment of weak agricultural extension and few credit services. My survey data show that approximately every third household has received some form of agricultural extension advice over the last two years. Such services have in most cases been provided by NGOs, while the governmental extension services have reached less than one tenth of the households. This corresponds to other research showing that the decentralisation of extension services in Uganda has led to a shortage of funds, technical supervision and outreach capacity, resulting in minimal impact on the village level (Francis and James 2003). One farmer describes the situation:

> In the past, extension workers actually helped farmers. They were available and they came to demonstrate in the fields. But now you hardly see anyone. I would say that it changed more than 20 years ago. Before they were not only more, but they also worked more effectively. You could get good advice on specific crops or other practices to improve farming. I would say that nowadays the NGOs are closer, but the extension workers are far away. I actually don't know where because you do not see them at all (Okello Lam).

As a result of multiple and interlocking stressors, food shortages are recurrent. Survey data indicate that as many as 65 percent of all households in Paya have suffered from food shortages in the last two years, which are described as rather typical years. Hardship typically occurs during the planting season and before early crops such as millet, maize and beans start to mature, that is, at times when food stocks from the previous harvest are low or have already run out. As self-sufficiency in food production is becoming more and more difficult to achieve, people increasingly rely on purchased food to cover basic needs (cf. Whyte and Kyaddondo 2006). The survey data show that two thirds of all households regularly buy staples to complement their own food production. There is a significant relationship between households that have experienced food shortage and those that buy staples, indicating that households relying on purchased food are those who fail to produce enough, rather than those who have diversified into non-farm activities. Among households who regularly buy staples, as many as 85 percent have suffered from food shortage during the previous two years, compared to 31 percent among those who rely on their own food production. This suggests that high and fluctuating food prices are an important source of vulnerability also among food producers themselves (cf. GoU 2012).

Around two thirds of households also sell some of their produce, mainly in local and regional markets. While the traditional cash crops – coffee and cotton – have become less profitable over time and are grown by a decreasing number of farmers (cf. Whyte and Kyaddondo 2006), maize has become the main income-generating crop. The growing importance of maize is seen also at the national level, where both cultivation area and exports have increased significantly over the two last decades (Ahmed 2012). Due to the lack of storage facilities, farmers generally have to sell their crops directly after harvest when prices are low. Poor infrastructure and lack of transportation means that farmers largely rely on middlemen who come to the villages and pay farmers at the farm-gate where they are in a poor price-negotiation position. As explained by one man:

> After the harvest, prices just drop. So even if we would produce much, we would get a very low price. That is not a good motivation for people to invest in farming. If we had the money to build a storage we could bulk the maize and sell it when the prices go up. And if we just had our own transport here to take our crops to where there is a good market-- we don't want to leave it to these buyers here, they eat the money on their way (Odoko Vincent).

As regards non-farm livelihood activities, my survey data show that about one third of households supplement their agricultural production with other income-generating activities, such as petty trading, brick-making, tailoring, beer brewing, charcoal production, cassava processing, bicycle taxis and casual labour. Short-term or seasonal urban labour migration is increasingly becoming a strategy to gain an income, particularly among young men. This is in line with Deborah Bryceson's (2002) and Frank Ellis' (2000) argument that livelihood diversification is a 'pervasive and enduring' element of rural livelihood strategies. However, in most cases these activities supplement rather than substitute farming, which remains the main occupation for most people. There are also important differences in livelihood opportunities available to households; among female-headed households, only 16 percent have incomes besides their own farming compared to 37 percent of male-headed households. This suggests that the former group are particularly dependent on their own food production while at the same time being more cash-constrained. The search for new avenues for income generation among farmers in Paya reflects the increasing requirements for cash to meet multiple demands such as school expenses, health care and food to satisfy basic needs. As observed by two elderly farmers:

> In the past, people only sold coffee and cotton, but now we are selling whatever we can, whatever we produce, because we need the money for almost everything (Obonyo Zaid).

> Now people are forced to sell what they planned to save, even the seeds saved for the next planting. Food insecurity in this area is getting worse (Apoya Margret).

These changes reflect the growing monetisation of the rural economy that has emerged over the last decade (Verma 2001, Whyte and Kyaddondo 2006, Morton 2007, Esuruku 2010, Gabrielsson, Brogaard et al. 2012). The fact that farmers are selling considerable parts of their harvest despite recurrent food shortages suggests that food production and food security are becoming increasingly delinked. This demonstrates the complex and multifaceted nature of smallholder vulnerability.

Soil management and degradation

Farmers in Paya are well aware of the problem of soil fertility decline and identify it as one of the main causes of the poor agricultural productivity and food insecurity in the area. This is worth emphasising since a common claim in both research and policy is that farmers' presumed lack of awareness is a key cause of the problem (cf. Scoones 2001, Verma 2001, Ramisch 2012). A wide range of practices are used by farmers in Paya to maintain and restore soil fertility. Some of these practices add nutrients to the farm, others help to reduce nutrient loss or enhance the recycling of nutrients within the farm (Semalulu, McDonagh et al. 2003). However, despite farmers' efforts, the options available to them are generally insufficient to maintain the long-term capacity of soils. In the following sections, farmers' own perceptions of the problem and the challenges they face in sustainably managing their land, as expressed in interviews and group discussions, will be outlined. Before I do so, I will give a brief overview of the type of soil management practices used by farmers in Paya. This largely builds on the survey, which included a number of pre-defined management options based on key informant interviews and the pilot survey, and complemented with narrative walks and group discussions to draw a fuller picture.

As shown in Figure 5, crop rotation and intercropping with nitrogen-fixing legumes are well-established practices used by the absolute majority of households in Paya. To prevent soil erosion, techniques such as cross-slope cultivation and planting grass strips between plots, as well as digging trenches, pits and other types of structures for water control, are applied by the large majority of farmers. Agroforestry, that is, functional integration of trees and shrubs in crop and livestock systems (Cornell 2007), is also practised by many households, although in varying degrees.

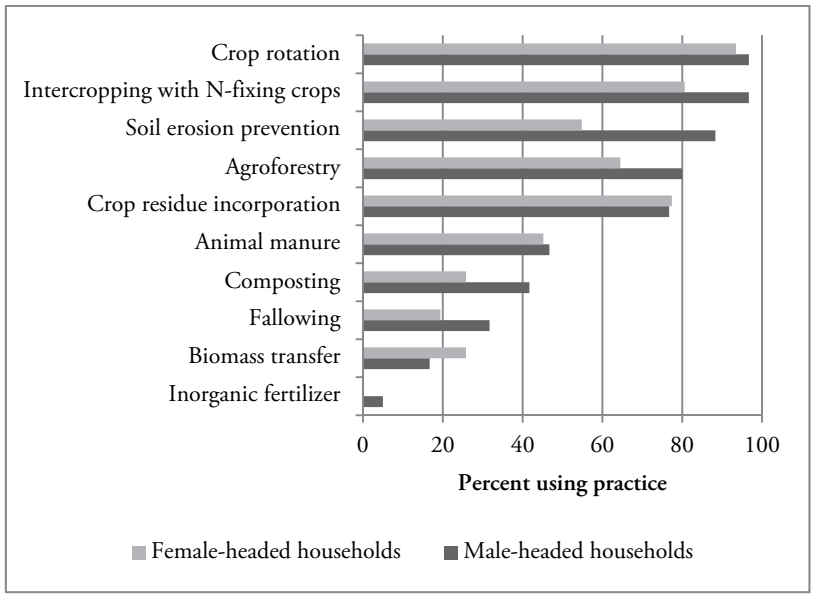


Figure 5. Use of soil fertility management practices among male- and female-headed households, N=100 (Survey data 2010).

More than three quarters of households incorporate their crop residues into the soil. This practice has increasingly come to replace the tradition of clearing fields by burning the residues and is one example commonly mentioned by farmers of how people are changing strategies as a response to soil fertility decline. Another interesting adaptation is what is locally called 'cassava fallowing' and 'sweet potato fallowing' which due to land scarcity is increasingly used as a substitute for traditional fallow. Cassava and sweet potato are perceived as crops that "rest the soil" and the typical explanation is that their deep roots can access soil nutrients unreachable by other plants and bring those to the topsoil through their large and continuous leaf production. Farmers claim that this type of "imitation fallow" improves the soil texture and contributes to yield improvement in the following crop. Similar observations have been made by Fermont et al. in East Africa (2008). Other soil management practices used by farmers include biomass transfer, that is, the collection of leaves and other green material to mulch into the soil. The use of animal manure and compost is practised by less than half of the households, while inorganic fertilizer is used by only a few. The level of adoption and the specific combinations of soil management practices vary considerably among households, reflecting differences in access to land, labour and other resources (cf. Scoones 2001, Pender, Ssewanyana et al. 2004, Tittonell, Muriuki et al. 2010). The lower levels of adoption for several of the practices among female-headed households, who are generally more resource-constrained, is a clear manifestation of this.

Symptoms of soil degradation

The long-term decline in crop yields and the deteriorating capacity at the household and community level to produce enough food to be self-sufficient is the most evident and important symptom of the poor and declining soil fertility identified by farmers in Paya. They frequently describe the soil as "old", "weak" and "worn out" (see Paper II). My survey data show that about two thirds of households experience that the productivity of their own land has decreased over the last ten years. About one tenth of households state that productivity remains the same, while one fifth experience that productivity increased. Interestingly, those who are members of farmer groups are overrepresented among those experiencing an improvement in land productivity, while the opposite is true for those experiencing a decrease (Figure 6). This supports the argument that farmer groups play an important role in strengthening farmers' capacities and incentives to manage land more sustainably, as developed in Papers II and IV.

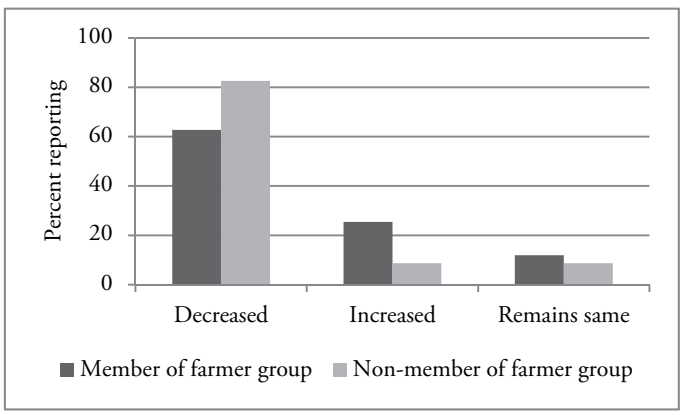


Figure 6. Farmers' perceptions of land productivity change over the last 10 years, N=91 (Survey data, 2010).

Farmers commonly experience that not only crop yields but also the quality of crops have declined. Many perceive that crop growth is slow, plants are stunted and plant leaves turn light green or yellow more often. One man explains:

> The crops grow slowly and they remain short and thin. They just do not look healthy anymore. It is the same almost everywhere here. Another sign is that the maize cobs are not fully packed. That is not how it used to be (Ochar Maseye).

Soil fertility decline is often associated with the increased sensitivity of crops to unfavourable weather conditions such as heavy rainfall and drought that many farmers observe. This, in turn, is generally related to a decreased capacity of the soils to absorb and retain water. Many farmers also report that crops have become more prone to various forms of pest and disease infestations. In particular *kayongo*, which is the local

name for *witchweed (Striga hermothica)*, is identified as a major problem. This invasive weed occurs mainly where soil fertility is low and is responsible for more crop loss than any other weed species in Africa. It mainly affects maize, millet and sorghum and damages the crop by attaching itself to the roots where it parasitizes on the host plant and harms its development (CABI 2014). The weed is locally also known as 'poverty weed' because it used to be associated only with the poorest fields, but over time it has become increasingly common in the area. As explained by one woman:

> Where *kayongo* grows it is just impossible because it takes over everything. It grows where the soil is poor, that is what it shows. We fear it, but we have got more used to seeing it now (Amollo Maria).

Besides productivity and crop quality, farmers associate soil fertility decline with changes in soil colour, texture, moisture and workability. Many perceive that soils are becoming more sandy, less "thick", "rich" and "fat" and lighter in colour than they used to be and fertility decline is reported to occur most rapidly in sandy soils. While soils with higher clay content are perceived as less sensitive to fertility loss, farmers often describe such soils as becoming increasingly hard and thus more difficult to work.

Drivers of soil fertility decline

Farmers in Paya attribute the problem of poor and declining soil fertility to a wide range of direct and indirect drivers. The complexity and multiple causes of the problem are illustrated in Fig. X, which builds on a problem tree exercise in which farmers were invited to identify various types of problem drivers, discuss how they are interrelated and arrange them accordingly. One of the direct drivers identified by farmers is the increasing pressure on land in the area, which has resulted in continuous cropping with limited fallow. It has also led to the expansion of cultivation into soils of poorer quality and increased fragmentation of land. My survey data show that less than a third of households let some part of their land lie in fallow but the periods of fallow have decreased drastically over time and in many cases they are limited to one single cropping season. In order for shifting cultivation systems to be sustainable, two year periods of cropping often require ten year periods of fallowing (Tian, Kolawole et al. 1999). One elderly man explains the problem:

> Thirty years ago it was still possible to increase the cultivated area but now there are no such areas left, everything is already cultivated. People used to leave the land to rest, at least for two years or more. But nowadays it is almost nothing. In the old times, for example when I bought this land [1965], people were not adding things like animal manure to the fields, or mulching with leaves. Maybe for the small garden, like vegetables, but not for the bigger fields. By then the land was fertile by itself, it really brought on more yield then (Obonyo Zaid).

Farmers are well aware of the problem but many times they are forced to continue their cultivation year after year because they lack the means for adequate soil fertility restoration. This not only contributes to soil nutrient loss but also reduces the content of soil organic matter which would help retain soil moisture, prevent nutrient leaching and is important for soil microorganisms (Ayuke, Brussaard et al. 2011). The problems of increasingly sandy and stony soils as well as of crops that are becoming more sensitive to drought, are clear indications of this, as reported by farmers. One woman complains:

> I cannot leave any of my land in fallow, because I have so little [0.6 ha], so I need it. The health of the soil has declined because of this constant cultivation without rest. But we all need food, so what can I do but continue? (Amollo Maria).

Soil erosion is another driver of poor soil fertility identified by farmers in Paya. The problem is widespread and nearly 90 per cent of the surveyed households experience it on their land. In particular, it is the first rains after a dry season that cause erosion on land where the protective vegetative cover is lacking due to grazing, burning or preparation of land for cultivation. This significantly affects soil fertility which is found mainly in the shallow topsoil (Magunda and Tenywa 2001). Farmers commonly describe soil erosion as a growing problem and generally associate it with changing rain patterns, mainly in terms of increasingly heavy rainfall. As described by one woman:

> At times it rains so heavily that the soil is just washed away, even where I have been digging to prevent it. My soils are sensitive because they are so sandy and light. Other times the rains are delayed and we just wait. So either there is too much or too little rain. We used not to mind putting those ridges in the past. But now, if you don't, you cannot prevent this soil erosion because it is behaving differently (Achieng Rose).

The third key cause of declining soil fertility identified by farmers is the general lack of organic material and access to soil management options, including inorganic fertilizer, which leads to inadequate restoration of soil fertility. As regards organic material, animal manure and various sources of biomass are two potential sources for soil improvement. However, as previously mentioned, the number of animals in the area has decreased dramatically and thereby also farmers' access to manure. High prevalence of animal diseases, poor access to veterinary services, as well as adjustment to the decreasing availability of pasture areas, are identified as key causes. Many farmers have sold animals during periods of hardship but have not been able to buy new in periods of recovery. The reduction in the number of animals can thus be seen as a reflection of the increasingly difficult livelihood conditions faced by people in the region. One farmer reflects on the problem:

> We used to have many goats and cattle but diseases are killing them. Local treatments do not work anymore and the veterinary service is so poor. And even if you get them, the medicine is very expensive and sometimes it is not even there. Another problem is that there is no place for grazing anymore, even if you tie the goats. We used to have big areas of common grazing land, but it has become smaller and smaller over the years. It used to be there in the wetlands but now people grow rice and there are no animals grazing there anymore. So we must find new ways to rear animals, because the manure is just too important. When you add it the soil becomes soft and easy to break. But we just don't have enough (Apoya Margret).

Another factor contributing to the lack of organic material is deforestation, which according to farmers is driven by the growing need for firewood, charcoal and timber, as well as expansion of land for farming and grazing. An elderly man explains:

> We used to have many trees that helped to add life to the soil by their leaves, but we no longer have that many left. Poverty is destroying almost everything (…) This area here used to be a thick forest. The bats you hear in the night are because of that forest. But almost everything has been cut down. Trees helped us in so many ways-- as windbreaks, for shade, they hold the soil, for construction, for fuel wood and you could also sell if you needed cash (Ochieng Simon).

Besides limited availability of organic soil input, labour constraints on collecting such material, in combination with poor access to wheelbarrows and other equipment to transport it to the fields, are pointed out by farmers as important barriers. High disease burdens, including HIV/AIDS which has hit the region hard, is one important factor inhibiting labour capacity. Organic resources are generally low in nutrient content and large quantities are therefore needed. In addition, such resources often have competing uses besides soil fertilization, such as animal fodder and cooking fuel. As regards inorganic fertilizer, very few households apply them to their soils due to high costs and limited access. This reflects the typical situation in Uganda, where fertilizer consumption is among the lowest in the world, averaging about two kilograms per hectare (World Bank 2013). High costs and limited availability are the most important reasons for the low consumption identified by farmers, followed by lack of knowledge on what type of fertilizer to use for various crops and how to apply it properly. Moreover, farmers commonly associate fertilizer use with various risks, including irregular and inadequate rainfall and fear that it will cause damage to the crops. Increasing climate variability may imply that farmers will perceive fertilizer use as even more risky in the future, as pointed out by Mapfumo et al. (2013). A widespread perception that soils get "addicted" to fertilizer and that regular application therefore is needed once it has been introduced may also prevent some farmers from buying it as they fear that they will fail to maintain investment over time.

Finally, the poor access to agricultural extension services, and their low quality, are recognized by farmers as other factors contributing to poor soil fertility. Many point out that they lack technical support and sources of information that could potentially improve agricultural productivity and soil management in the area. However, numerous farmers emphasise that the value of knowledge ultimately depends on the ability actually to put it into practice. Both women and men point out that the general lack of alternative income-generating activities and the limited availability of credit services, in combination with low producer prices, are an obstacle to all types of capital-intensive practices. As explained by one man:

> Even if we learn about new practices or if there are fertilizers or these other [improved] seeds-- if we don't get better prices or cannot process what we produce, people won't adopt these practices because the money is lacking (Odoko Yokolam).

To summarize, farmers' analysis of soil fertility decline shows that the drivers of the problem are complex and interlinked and that the problem must be seen in a broader context of environmental, socio-economic and political changes. The problem tree sketched by farmers in Paya largely matches other descriptions of soil productivity problems in smallholder agriculture in sub-Saharan Africa (e.g. Scoones 2001, Verma 2001, Sanchez 2002, Pender, Place et al. 2006, Giller, Tittonell et al. 2011). This is not to say that either the problems, or their solutions, apply equally as regards all regions, farming systems or individual farmers. Rather, the complexity and diversity of smallholder farming systems and livelihood strategies demonstrate that farmers' active participation in problem solution is essential for the development of solutions that are relevant to their specific conditions.

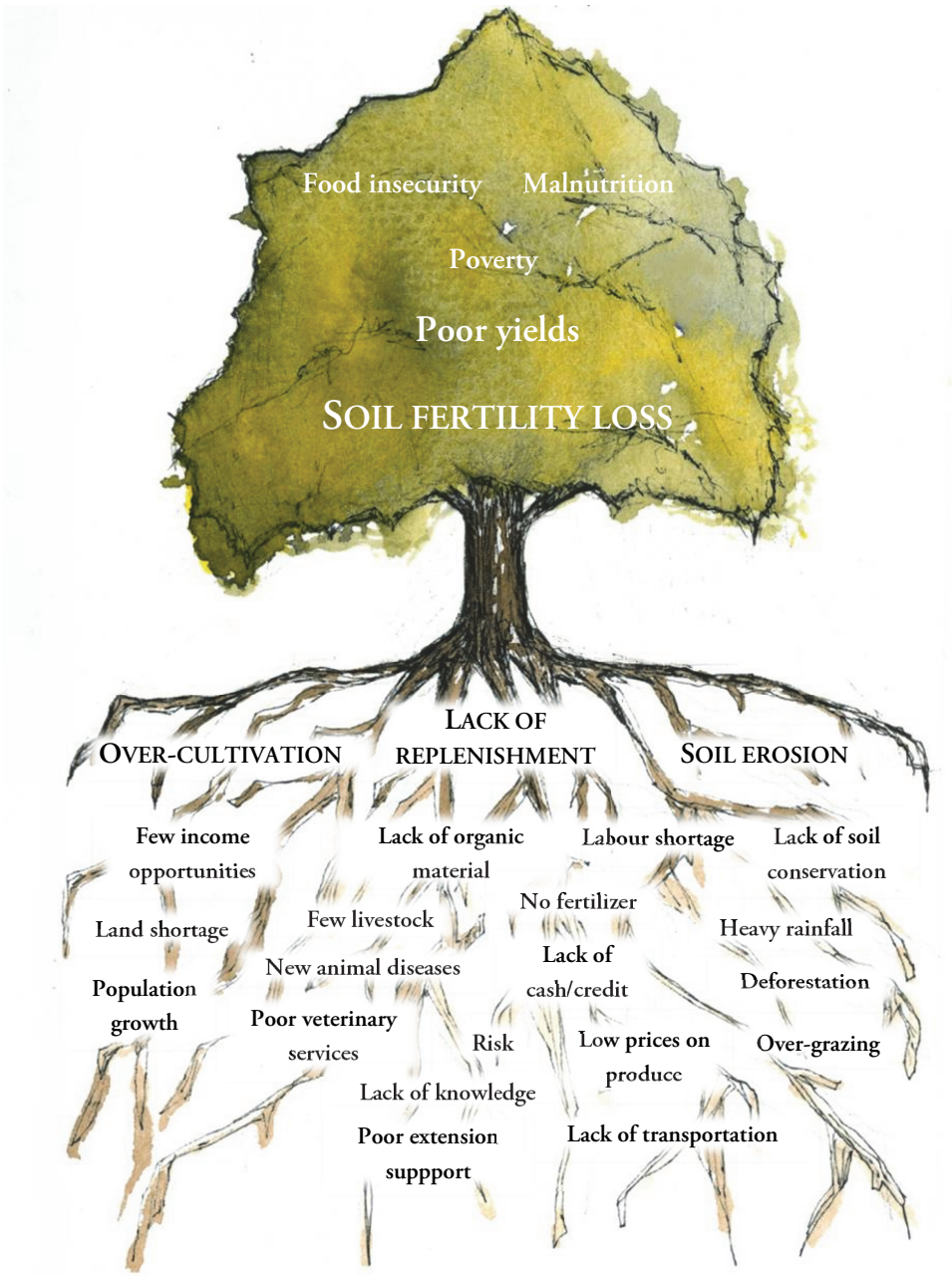


Figure 7. Soil fertility loss: a participatory problem tree analysis (Fieldwork data 2010).

The agro-political scene in Uganda

Agriculture remains a key sector in the Ugandan economy, contributing one fifth of GDP, nearly half of the of export earnings and the bulk of industrial raw materials (GoU 2013a). Just like in Tororo, the sector at large is dominated by smallholder farming, which serves as the livelihood for nearly 80 percent of the population (GoU 2007) and accounts for more than three quarters of the total agricultural production in the country (Salami, Kamara et al. 2010). This illustrates the strong and continued dependence on agriculture for both the national economy and individual well-being, and it underlines the importance of sustainable land management. In this section, I will briefly outline some of the policy directions for agricultural development in Uganda, including the resurgence of interest in farmer organisations and cooperatives.

Agricultural modernisation as a route to pro-poor development?

As reflected in various national policy documents, the Ugandan Government has during the last decade emphasised that agricultural development is crucial for achieving broader development objectives, particularly in relation to poverty eradication. This is much in line with the renewed attention given to agriculture at the global level and the ongoing effort among African governments and the international development community to promote a new 'African Green Revolution' (World Bank 2007, Toenniessen, Adesina et al. 2008, Sumberg and Thompson 2012). In 2000, the Ugandan government outlined the 'Plan for Modernisation of Agriculture' (PMA) as the overall policy framework for agriculture. It is portrayed as "a holistic, strategic framework for eradicating poverty through multi-sectoral interventions enabling the people to improve their livelihoods in a sustainable manner" (GoU 2000:xi). Increased agricultural productivity is meant to serve as a basis for pro-poor development, increased efficiency in land use, as well as a key driver for growth in other economic sectors. In line with dominant development narratives, agricultural development is thereby cast as a stepping stone to a more modern Uganda: "as employment opportunities grow in other sectors, people will leave agriculture, and the share of agriculture in employment will diminish over time" (GoU 2000:vii). The country's National Development Plan (NDP) for 2010-2015 specifies some of these goals with the overall vision of transforming Uganda "from a peasant to a modern and prosperous country within 30 years" (GoU 2010b:1).

However, the current level of public investment in the agricultural sector does not match governmental rhetoric. For the financial year 2013/2014, the allocation to agriculture was only 3.4 per cent of the national budget (GoU 2013b). This makes it one of the lowest ranked sectors, implying that the chronic underfunding of agriculture in the 1980s and 1990s largely remains. The current investment level is well below the

10 percent budget allocation target that Uganda and other African governments committed themselves to in line with the Comprehensive Africa Agriculture Development Programme (CAADP) (African Union 2003) as well as below the 4.6% funding that the government aimed for that year in the NDP (GoU 2010b). The low levels of public investment in agriculture are reflected in the bleak performance recorded during recent years; the sector grew by only 1.4 percent in 2012/2013 and 0.8 percent in 2011/2012 (GoU 2013a). This stands in sharp contrast to the annual growth target of 5.5 percent declared in the NDP (GoU 2010d) and the 6 percent annual target of the CAADP. With an annual population growth of around 3.2 percent, per capita agricultural production has thereby declined. Given that the population is expected to increase from 35.4 million in 2013 to 100 million in 2050 (GoU 2013a), this poses enormous challenges for Uganda's economy and rural livelihoods in particular. As Joughin and Kjær (2010) point out, much of earlier growth in agricultural output can be attributed to area expansion rather than intensification, which obviously cannot continue indefinitely. This is reflected in a general stagnation of agricultural productivity recorded in Uganda since the 1990s, as well as in a slowdown in poverty reduction during the same period (Benin, Thurlow et al. 2012).

The government of Uganda has outlined three key rural policy goals: agricultural growth, poverty reduction and regional equity (GoU 2010b). Given these goals, not only the low public spending on the sector is highly problematic but critical voices have also been raised regarding funding choices and general directions taken for Uganda's agriculture. Numerous scholars have emphasised that agricultural growth in and of itself will not automatically lead to poverty reduction and they criticise the PMA because it does not include clear and targeted reforms that are most likely to benefit the poorest groups of farmers (Bahiigwa, Rigby et al. 2005, Flygare 2006). Moreover, in an effort to expand export revenues, agricultural investments tend to be targeted on the production of cash crops rather than food crops, thereby primarily benefiting farmers with more land and resources (Bahiigwa, Rigby et al. 2005, Hickey 2013). This is seen also in the recently introduced 'Commodity Based approach' (GoU 2013b:iv) which prioritizes government support for the production of strategic market commodities rather than subsistence crops. In line with this, the government has recently shifted its attention to irrigation, which is now receiving a larger share of funding than both rural infrastructure and agricultural research and extension services. While each of these areas have been chronically underfunded in the past, Pauw and Thurlow (2013) argue that the current prioritisation is misguided and that it is not likely to contribute to the rural policy goals. As Hickey (2013) argues, the current agricultural policy, or at least its practice, thereby seems generally ill-suited to provide appropriate support for the vast majority of smallholder farmers.

The directions taken by the Ugandan government simultaneously demonstrate the one-sided commitment to the marketization of agricultural production as a route to economic growth and poverty eradication. As the PMA exemplifies, the objective of

Uganda's agricultural policy is to eradicate poverty by "transforming subsistence agriculture to commercial agriculture" (GoU 2000:28). It argues that "improving the welfare of poor subsistence farmers will require that they re-orient their production towards the market" (GoU 2000:28). This focus on agricultural commercialisation prevails as the PMA was revised into the National Agricultural Policy (NAP) in 2011 (GoU 2011). The relatively low level of market integration among farmers in the country has indeed been a key concern for years, which partly explains the funding priorities put forward. The generally poor quality and coverage of rural roads for example negatively affects farmer's access to markets and results in high transportation costs, thus reducing farmers' revenues and increasing costs for agricultural inputs and other products (Salami, Kamara et al. 2010). But while increasing market integration brings with it opportunities for income diversification, it has also introduced a new set of challenges into the lives of smallholders (Morton 2007). Recent experiences with volatile food prices have demonstrated how increasing market dependence can constitute an important source of vulnerability, in farmers' capacity both as producers and consumers. This adds up to the multiple sources of vulnerability that are inherent in rain-fed smallholder agriculture, as seen in Paya. The high level of vulnerability is also reflected in the recent poverty statistics; while the percentage of the Ugandan population living below the national poverty line has decreased from 56.4 percent in 1992/1993 to 24.5 percent by 2009/2010, the category 'non poor but insecure' has during the same period increased from 33 to 43 percent, along with increased inequality. This means that many of those who have escaped poverty remain highly vulnerable, and market insecurity is identified as a key contributing factor (GoU 2012). This has implications for the kind of strategies that farmers choose to adopt and has for example made many rural households "reluctant to invest in new technologies such as fertiliser" (GoU 2012). This is all the more problematic given that the Ugandan government sees the "uptake of modern farming techniques" (GoU 2000:vi) as one of the main ways in which agricultural growth can be achieved.

Land and soil

As regards the sustainability of land management, soil fertility decline was for long an issue receiving relatively little attention in Uganda (Egulu and Ebanyat 2000). However, it has increasingly been identified as a key constraining factor in agricultural development (GoU 2011), which reflects the general discussions for African agriculture where the issue has become a top priority (Scoones 2013). To exemplify, sustainable land management is the first of the four pillars of the CAADP (2009). An integrated soil fertility management approach, which recognises the need to combine organic and inorganic inputs and emphasises the need for context-specific solutions, is now widely accepted as the most appropriate response (Vanlauwe, Bationo et al. 2010). However, the type of policy directions and specific measures to support this in practice continue

to be contested issues, as discussed in Paper 1. The focus of the Ugandan government, as of many African governments and various initiatives such as AGRA and CAADP alike, is mainly to increase the availability and use of inorganic fertilizer (GoU 2011). In efforts to do so, a key issue of debate has been the use of subsidies and other economic incentives (Marenya, Nkonya et al. 2012, Benson, Lubega et al. 2013).

Despite the aim of the integrated soil fertility management paradigm to move away from the uniform 'technology-package' solution and to integrate science-driven knowledge with local stakeholders' creativity and experience (de Jager 2007), it thereby seems as if the uniform prescription of inorganic fertilizers largely continues. Under the 'Abuja Declaration', Uganda has committed to increase fertilizer use to at least 50 kg per hectare by year 2015 (African Union 2006). Given the current level of about 2 kg per hectare (World Bank 2013) this seems largely unrealistic and stronger efforts are clearly needed to also promote the development of alternative soil fertility practices that are compatible with highly complex and variable smallholder farming systems. Indeed, strategies set to improve land management in the NAP include "the dissemination of appropriate technologies and practices for agricultural resources conservation and maintenance among all categories of farmers" (GoU 2011:30). However, little has been done to implement this in practice, partly due to the poorly functioning agricultural extension system in the county. There seems to be general agreement that decentralisation policies, introduced in Uganda in the late 1990s and aimed at transferring functions and responsibilities to the local level as a means to improve rural access to services, have had negative impacts on the agricultural extension system in terms of underfunding, poor coordination of actions and low implementation capacity of programmes at local levels (Egulu and Ebanyat 2000, Francis and James 2003, Joughin and Kjær 2010, Bashaasha, Mangheni et al. 2011).

More indirect measures intended to improve land management have been seen in the 1998 Land Act and the recent revision of the National Land Policy, where a central objective is to strengthen land tenure security and investment in land through formalised and individualised land rights (Hundsbæk Pedersen, Spichiger et al. 2012). However, scholars maintain that neither the argument that tenure insecurity is widespread in customary tenure, nor that land titling would improve farmers' investments in land, is supported by research (Munk Ravnborg, Bashaasha et al. 2013). Concerns have moreover been raised that the reforms may weaken women's access to and control over land (Tripp 2004, Adoko, Akin et al. 2011, Hundsbæk Pedersen, Spichiger et al. 2012), which would negate much of what the policies are intended to do. As previously pointed out, it is also of crucial importance to pay more attention to the prevailing gaps between legal rights and actual practice, and to seek effective strategies to address such gaps.

The cooperative hope

Since the early 2000s, the Ugandan government has emphasised that farmer organisations and cooperatives play vital roles in the effort to modernise and commercialise agriculture (Flygare 2006). The need to revive the cooperative movement, which used to be vibrant in the country, is outlined in both the NDP and the NAP strategy to address the multiple challenges faced by rural producers, including access to markets and rural services (GoU 2010d, GoU 2011). As discussed in Paper III, this reflects a rather instrumental view whereby group formation among farmers is promoted mainly on the basis of efficiency arguments rather fairness. The cooperative movement in Uganda was actively supported and promoted by the government during the post-independence period as an important instrument for agricultural production and marketing. Their importance gradually dwindled as a result of civil war, political instability and mismanagement during the Amin regime, in combination with the implementation of the Structural Adjustment Programmes (SAPs) in the 1990s (Mrema 2008, Kwapong and Korugyendo 2010). Following the increased recognition that SAPs have largely failed to bring improvements to the rural population, the cooperative model has again gained attention as a potentially effective strategy to support broad-based agricultural development. The government's 'Co-operative Development Policy', introduced in 2008, states that "a revitalized cooperative movement holds one of the most important keys to resolving problems related to sustainable, people-centered and equitable development" (GoU 2008:3).

As further developed in Paper III, this renewed attention to cooperatives and farmer organizations needs to be seen in the context of the market-oriented development processes outlined above. Indeed the main aim of Uganda's cooperative policy is "to rebuil[d] and revitaliz[e] cooperatives as key business units in the economy" (GoU 2008:12), seen as representing a "great potential to create employment, generate wealth and equitably distribute it" (GoU 2008:2). However, policy documents remain ambiguous about the form and extent that this support will take. In line with the overall agricultural policy, the priorities outlined in the plan suggest a market approach which risks being out of touch with the realities and capacities of rural smallholders. While it remains to be seen what concrete forms the government's token embracement of the co-operative movement will take, the persistent shortfall in agricultural funding suggest that there is at least a danger here that the benefits will be limited for the vast majority of smallholder farmer organizations and community groups. Instead, the new attention given to these groups risks serving as an easy way to reframe the use of existing resources, knowledge and farmer labour as a new development approach without offering much in return.

5. Conclusions and contributions

I draw three main conclusions from my research, all of which refer to the political ecology themes that frame this work. First, land degradation in smallholder farming must be understood and treated as an integrated social, political and agro-ecological issue. Secondly, collective action among farmers is an important but not a sufficient strategy to secure agricultural livelihoods. And thirdly, co-production of knowledge is crucial in the formulation of locally relevant, effective and affordable soil management practices. The thesis contributes potential ways of 'thinking and doing' political ecology in terms of engaging critically with dominant narratives on land degradation; advancing understandings on the merits and limits of collective action in the context of rural livelihoods; and providing insights on solutions-oriented research in support of sustainability. In this concluding chapter, I recap and interrelate the findings and arguments developed in the four papers and reflect on the overall conclusions, contributions and potential issues for further research.

Challenging dominant narratives – modifying the debate

I started this research project with an ambition to understand the complexities of local experiences and perceptions of soil degradation in smallholder communities. By thoroughly grounding my research empirically while letting theory inform the analytical process, I attained a rich material for exploring the 'everydayness' of soil in a way that integrates . Multiple methods based on interaction with farmers allowed for integrating environmental and social dimensions. In line with widespread narratives my research clearly shows that low and declining soil fertility is a major problem with significant negative impact on agricultural production, food security and well-being. But by drawing on farmers' own analyses and personal narratives – which is crucial to an understanding of soil issues in a broader livelihood context – the research also reveals a much more complex and nuanced story than the dominant narrative in research and policy permits. The problem tree, which farmers designed, illustrates how decline in soil fertility is interwoven with everyday constraints and vulnerabilities. In addition to population pressure on limited land, these include climate change impacts, heavy disease burdens and price fluctuations as well as serious shortcomings in government support and public investment in agriculture and infrastructure. Soil fertility decline is

thus caused by multiple drivers at various scales and is only one of many challenges that smallholders have to contend with in a context where livelihoods are increasingly difficult to secure. This suggests that the 'soil fertility crisis' signifies a broader crisis of rural poverty and food insecurity.

Going further into the complexities and drawing on feminist political ecology in doing so, I have analysed how farmers' capacities and strategies to respond to soil fertility loss, both individually and collectively, are socially differentiated. The research shows that gendered division of labour and inequalities in access to and control over land are at the centre of such dynamics. Although women are mostly responsible for farming, they are largely disadvantaged in controlling the proceeds of their own efforts and in gaining access to resources that are critical for sustaining the long-term capacity of soils. In addition, my research indicates that increasing land scarcity may further weaken the position of women in pursuing claims to land rights. The complexity of these issues clearly goes beyond what can possibly be captured by framing soil fertility decline in terms of 'nutrient budget' deficits. Taken together this demonstrates that land degradation cannot be solved by technical solutions alone but must be treated as an integrated social, political and agro-ecological issue.

I see two important topics for future research. First, in a context where the pressure on land is growing and further exacerbated by the global rush for land in Africa, important issues for research and policy is to investigate the implications of this for land management and degradation, as well as how gender intersects with other axes of power in struggles over land. Secondly, given farmers' already high degree of vulnerability climate change pressures in combination with increasing integration of farming systems in the global market economy will have profound impacts on rural livelihood dynamics. While current approaches to soil management are often narrowly framed, there is a need to define supportive institutions and practices that acknowledge the interactions between multiple stressors and that can simultaneously enhance the long-term productive capacity of soils and the ability of farming systems to cope with risk and uncertainty.

Acting collectively – navigating creatively

In an attempt to challenge the tendency to portray farmers as powerless victims of change, as witnessed in debates on land degradation, I have explored and illuminated the concrete, everyday strategies that they employ in response to soil fertility decline and related challenges. As such, I seek to unite the twin goals of political ecology (Robbins 2012) – to understand how individuals and communities are affected by environmental change while recognising their agency and creativity in the ways problems are tackled. A central finding is that new forms and functions of collective

action, through the medium of multi-purpose groups, have been initiated as a long-term response to land degradation and other interlinked stressors. Such 'communities of practice' (Wenger 1998), in which mainly but not exclusively women engage, play significant roles in overcoming barriers that often obstruct individual coping strategies. By pooling labour and other critical resources, farmers coordinate actions and make better use of limited assets. Groups also provide important arenas for knowledge generation, risk-sharing and income-generation through joint experimentation with farming practices and marketing of produce. Collective saving and informal credit further help members to plan ahead and serve as a social safety net that strengthens their ability to cope with short term shocks and crises. Groups thereby serve several functions in enhancing members' capacities and creating incentives to manage land sustainably, thus demonstrating that soil degradation is not an inevitable problem. In conclusion, collective action is an important, and potentially growing, strategy for addressing immediate, practical problems, as well as for building capacity and seeking strategic interests in the longer term. It can thereby be understood as one form of 'creative navigation' (Truelove 2011) to secure livelihoods in an increasingly stressful environment.

Nevertheless, my research shows that collective action, despite its merits, is not the simple remedy for rural development and natural resource management that governments and development actors alike increasingly tend to portray it as being. Feminist political ecology provided a critical lens in my exploration of the the micro-politics and gendered dynamics of collective action. Three important findings have emerged from my research. First, individual's ability to participate in and benefit from collective action is socially differentiated and influenced by unequal access to resources, power and social status. This implies that economically and socially disadvantaged farmers are at risk of being excluded. Secondly, numerous structural barriers limit the type of actions and the extent of change that can be achieved through self-organisation among farmers at the local level. These include smallholder farmers' largely disadvantageous position in agricultural markets, the general lack of institutional support due to chronic underfunding of the agricultural sector, and multiple sources of vulnerability inherent in persistent poverty. Thirdly, collective action is driven mainly by women's work and engagement (cf. Moser 2003). The implications of this are double-edged. On the one hand, collective action may offer women 'room to manoeuvre' in a strongly patriarchal society – both by increasing their access to critical resources such as land, labour, cash and knowledge, and by creating a space for 'everyday politics' (Kerkvliet 2009) and solidarity. On the other hand, collective action also adds to women's already high labour burdens and subsequent time-poverty, whereas the outcomes of collective action often bring benefits to the community at large.

While research under the broad label of feminist political ecology has mainly focused on the empowering aspects of collective action and social organisation as a bottom-up

strategy in struggles over resources, my research demonstrates the importance of problematizing women's role as 'community managers'. It draws attention to its potentially disempowering impacts as group approaches are increasingly promoted in rural development and natural resource management. There is a risk that such promotion, if uncritical, will reinforce existing socio-economic differences and exacerbate the labour burden on women, without offering them a route for strategic engagement, and may thereby entrench existing gender inequalities. Furthermore, transition from informal 'communities of practice' to formal producer organisations cannot be assumed, unless adequate measures for support and capacity-building are put in place. Without gender-sensitive strategies and sustained investment in rural development that specifically target the needs of smallholder farmers, collective action will therefore likely remain a strategy for 'getting by' rather than 'getting out' of poverty.

An important area for further research will be to investigate what specific policy frameworks and institutional support can encourage and enable forms of collective action that are most likely to benefit, in particular, women and economically poor groups, without the risk of co-opting farmers' self-organisations by treating them as a substitute to investment in agriculture or devolving the responsibility for finding solutions to the local level. We also need to understand better the gender-specific factors that constrain women from advancing collective action efforts and how such barriers can be reduced.

Advancing sustainability – conducting transdisciplinary research

Underpinned by the goal of sustainability science to link knowledge to action, my objective has also been to explore how land management strategies can be improved in collaboration with farmers. 'Collective strategies' in the thesis title thereby refers not only to social organisation among farmers but also to a mode of research. A core aspiration of sustainability science and political ecology alike is to integrate knowledge from academic and non-academic communities as a means of supporting co-production of strategies and practical solutions towards sustainability. Yet, how this can be pursued in practice is a critical challenge and empirical contributions remain limited (Kates et al. 2001, Miller et al. 2013). Despite the oft-repeated message in research and policy on land degradation that stakeholder involvement is necessary in order for appropriate practices to be developed, standardised solutions and technology transfer approaches largely prevail in practice. By engaging a number of farmer groups in the research process, I have, together with farmers, explored one way in which this gap between theory and practice can be bridged. The thesis thereby provides insights on how action research can be employed to envision, implement and evaluate a locally

anchored solution in collaboration with farmers. Proceeding from joint identification of context-specific opportunities and constraints, this process did not only generate a practical outcome previously not used in the setting – the use of human urine as a crop fertilizer – but also served to investigate and stimulate farmers' agency and social learning.

The overall conclusion from the action research process, in which the practice was tested and evaluated, is that urine fertilization is a viable strategy to enrich soils. It demonstrated significant yield impacts – even higher than inorganic fertilizer – and was evaluated by farmers as an efficient, low-cost and low-risk practice. It can make important contributions to food security and incomes even if only used on a small scale and it is particularly suitable for farmers with limited options in soil management, not least women. Based on these results, I argue that the use of urine as a source of soil nutrients is a practice that deserves more attention. Considering principles of resource-use efficiency, nutrient recycling and precision-agriculture it should be treated as an integral part of ongoing efforts to promote agricultural intensification in sub-Saharan Africa. Also for the objective of global sustainability there is need for alternative fertilizer sources and improved nutrient circulation to reduce the depletion rate of the world's nutrient reserves (Cordell et al. 2009, Dawson and Hilton 2011).

This experience shows that action research offers great potential for engaging practically with the complex interactions between social and environmental aspects of sustainability issues in a solutions-oriented manner. The process generated an in-depth understanding of the multiple criteria and trade-offs influencing farmers' technology choices and attitudes towards a new practice, with aspects ranging from yield impact and labour demand to social acceptability and risk. This underlines the need to pay attention to all kinds of context-specific "details", which may be fundamental to whether a certain practice will take root or not. A further important insight is that collective action, where farmers jointly develop new procedures, serves as an important space for crafting creative solutions and negotiating norms and taboos that can influence the adaptation and acceptance of new solutions. Co-production of knowledge may thereby create a sense of local ownership of the research process and foster a learning environment that stimulates communities to adapt to changing conditions. Hence, this work serves to advance a more 'practical political ecology' (Rocheleau 2008) and demonstrates that place-based, transdisciplinary research may provide fertile grounds for promoting action towards sustainability.

6. Looking ahead

Our obligations to the people and communities involved in research do not end when we leave 'the field' or publish our research. My next step is to organise a workshop for research dissemination in Tororo and produce a short film in collaboration with farmers. This is an attempt to re-integrate the knowledge generated in this research project into science and society – a key principle of transdisciplinary research (Lang et al. 2012). In the form of a dialogue, the objective is to present and discuss research findings with stakeholders, including local farmers, researchers, agricultural extension workers, government officials, policy makers and NGO representatives. While dialogue in and of itself does not suffice to bring about social change, the workshop will provide an occasion to reflect on the research findings, brainstorm about new ways to respond to challenges, and jointly formulate action strategies feasible within the given constraints. The workshop will also serve as a platform for various farmer-led initiatives, such as demonstration gardens and drama performance, all aimed at drawing attention to the use of urine fertilizer as one solution to soil fertility decline. The film will document the practice as well as the trials and tribulations experienced by farmers in implementing the system. It will furthermore serve as a forum for how the system can be scaled-up through improved systems and new sources for collection, as well as a mechanism for out-scaling the practice to include new geographical locations. Moving beyond the mere 'reporting back' of findings creates new arenas for advancing one key aim of sustainability science, namely to move knowledge into societal action. It will also serve to close the book on this research project, and expose opportunities for new research endeavours.

References

Adger, W. N., Benjaminsen, T. A., Brown, K. and Svarstad, H. (2001). "Advancing a political ecology of global environmental discourses." Development and change **32**(4): 681-715.

Adoko, J., Akin, J. and Knight, R. (2011). Understanding and Strengthening Women's Land Rights Under Customary Tenure in Uganda, Land and Equity Movement in Uganda (LEMU) and International Development Law Organization (IDLO).

African Union (2003). Maputo Declaration. Maputo, Mozambique.

African Union (2006). Abuja Declaration on Fertilizer for the African Green Revolution. Africa Fertilizer Summit: African Union Special Summit of the Heads of State and Government. Abuja, Nigeria.

Agarwal, B. (2000). "Conceptualising environmental collective action: why gender matters." Cambridge Journal of Economics **24**(3): 283-310.

AGRA (Alliance for a Green Revolution in Africa) (2009). "Restoring Soil Health in Africa." Retrieved 2009-11-04, from www.agra-alliance.org/section/work/soils

Agrawal, A. (2003). "Sustainable governance of common-pool resources: context, methods, and politics." Annual Review of Anthropology: 243-262.

Ahmed, M. (2012). Analysis of incentives and disincentives for maize in Uganda. Technical notes series, MAFAP. Rome, FAO.

Ayuke, F., Brussaard, L., Vanlauwe, B., Six, J., Lelei, D., Kibunja, C. and Pulleman, M. (2011). "Soil fertility management: impacts on soil macrofauna, soil aggregation and soil organic matter allocation." Applied Soil Ecology **48**(1): 53-62.

Baden, S. (2013). "Women's collective action in African agricultural markets: the limits of current development practice for rural women's empowerment." Gender & Development **21**(2): 295-311.

Bahiigwa, G., Rigby, D. and Woodhouse, P. (2005). "Right target, wrong mechanism? Agricultural modernization and poverty reduction in Uganda." World Development **33**(3): 481-496.

Bailey, S. and Bryant, R. (1997). Third world political ecology: an introduction. London and New York, Routledge.

Bashaasha, B., Mangheni, M. N. and Nkonya, E. (2011). Decentralization and rural service delivery in Uganda. IFPRI Discussion Paper 01063, International food policy research institute.

Becker, H. (1998). Tricks of the Trade: How to Think About Research While Doing It. Chicago and London, University of Chicago Press.

Benin, S., Thurlow, J., Diao, X., Kebba, A. and Ofwono, N. (2012). Uganda. Strategies and priorities for African agriculture: Economywide perspectives from country studies. X. Diao, J. Thurlow, S. Benin and S. Fan. Washington DC, USA, International Food Policy Research Institute.

Benjaminsen, T. A., Aune, J. B. and Sidibé, D. (2010). "A critical political ecology of cotton and soil fertility in Mali." Geoforum **41**(4): 647-656.

Benson, T., Lubega, P., Bayite-Kasule, S., Mogues, T. and Nyachwo, J. (2013). Uganda Strategy Support Program: The supply of inorganic fertilizers to smallholder farmers in Uganda. Policy Note 16. Kampala, The International Food and Policy Research Institute.

Bergman Lodin, J., Paulson, S. and Mugenyi, M. S. (2012). "New seeds, gender norms and labor dynamics in Hoima District, Uganda." Journal of Eastern African Studies **6**(3): 405-422.

Bettini, G. and Andersson, E. (2014). "Sand Waves and Human Tides: Exploring Environmental Myths on Desertification and Climate-Induced Migration." Journal of Environment & Development **23**(1): 160–185.

Blackden, C. M. and Wodon, Q. (2006). Gender, time use, and poverty in sub-Saharan Africa. Washington, DC., World Bank.

Blaikie, P. (2008). "Epilogue: Towards a future for political ecology that works." Geoforum **39**(2): 765-772.

Blaikie, P. and Brookfield, H. (1987). Land degradation and society. London, Routledge.

Brown, K. and Westaway, E. (2011). "Agency, capacity, and resilience to environmental change: lessons from human development, well-being, and disasters." Annual review of environment and resources **36**(1): 321.

Bryceson, D. F. (2002). "The scramble in Africa: reorienting rural livelihoods." World Development **30**(5): 725-739.

Brydon-Miller, M., Greenwood, D. and Maguire, P. (2003). "Why action research?" Action Research **1**(1): 9-28.

Bryman, A. (2008). Social Research Methods. Oxford and New York, Oxford university press.

Bujra, J. (2006). Lost in translation? The use of interpreters in fieldwork. Doing development research. V. Desai and R. Potter. London, SAGE Publications: 172-179.

CAADP (2009). Pillar I Framework: Sustainable Land and Water Management The Comprehensive Africa Agriculture Development Programme.

CABI (2014). "Striga hermonthica." Invasive Species Compendium. Retrieved 2014-04-21, from http://www.cabi.org/isc/?compid=5&dsid=51849&loadmodule=datasheet&page=481&site=144.

Carswell, G. (2003). "Continuities in environmental narratives: The case of Kabale, Uganda, 1930-2000." Environment and history **9**(1): 3-29.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., Jäger, J. and Mitchell, R. B. (2003). "Knowledge systems for sustainable development." Proceedings of the National Academy of Sciences **100**(14): 8086-8091.

Chambers, R. (1997). Who's Reality Counts? Putting the first last. London, Intermediate Technology Publications.

Chenery, E. M. (1960). An introduction to the soils of the Uganda Protectorate, Research Division, Department of Agriculture, Uganda.

Cleaver, F. (2007). "Understanding agency in collective action." Journal of human development **8**(2): 223-244.

Cleaver, K. M. and Schreiber, G. A. (1994). Reversing the spiral: the population, agriculture, and environment nexus in sub-Saharan Africa. Washington, DC., World Bank.

Cobo, J. G., Dercon, G. and Cadisch, G. (2010). "Nutrient balances in African land use systems across different spatial scales: a review of approaches, challenges and progress." Agriculture, ecosystems & environment **136**(1): 1-15.

Cornell, J. (2007). Agroforestry. Encyclopedia of Earth. M. T. E. Miller and C. J. Cleveland. Washington D.C., Environmental Information Coalition, National Council for Science and the Environment. from http://www.eoearth.org/article/Agroforestry.

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches. Thousands Oak, London and New Delhi, Sage.

de Jager, A. (2007). Practice makes perfect: participatory innovation in soil fertility management to improve rural livelihood in East Africa. Wageningen, The Netherlands, Wageningen University. PhD Thesis.

Delve, R. and Ramish, J. (2006). Land Management Options in Western Kenya and Eastern Uganda. Strategies for Sustainable Land Mangament in the East African Highlands. J. Pender, F. Place and S. Ehui. Washington, D.C., International Food Policy and Research Institute.

Doss, C. R. (2001). "Designing agricultural technology for African women farmers: Lessons from 25 years of experience." World Development **29**(12): 2075-2092.

Egulu, B. and Ebanyat, P. (2000). Policy processes in Uganda and their impact on soil fertility. Edinburgh, IIED. Drylands programme.

Ellis, F. (2000). Rural livelihoods and diversity in developing countries. Oxford, Oxford University Press.

Elmhirst, R. (2011). "Introducing new feminist political ecologies." Geoforum **42**(2): 129-132.

Escobar, A. (1999). "After Nature: Steps to an Antiessentialist Political Ecology 1." Current anthropology **40**(1): 1-30.

Esuruku, R. (2010). "Political and Social Economy of Gender and Rural Livelihoods in Uganda." Journal of Development Studies **1**(1): 163-178.

Fairhead, J. and Leach, M. (2005). "The centrality of the social in African farming." IDS bulletin **36**(2): 86-90.

FAO (1996). Recapitalization of soil productivity in Sub-Saharan Africa. FAO Investment Centre Occasional Paper Series N. 5. Rome, Food and Agricultural Organisation of the United Nations.

FAO (2011a). Women in agriculture: Closing the gender gap for development. The State of Food and Agriculture 2010-2011. Rome, The Food and Agricultural Organisation of the United Nations.

FAO (2011b). The State of Food and Agriculture 2010–2011: Women in Agriculture: Closing the Gender Gap for Development. Rome, The Food and Agricultural Organisation of the United Nations.

Fermont, A., Van Asten, P. and Giller, K. (2008). "Increasing land pressure in East Africa: The changing role of cassava and consequences for sustainability of farming systems." Agriculture, ecosystems & environment **128**(4): 239-250.

Fischer, E. and Qaim, M. (2012). "Gender, agricultural commercialization, and collective action in Kenya." Food Security **4**(3): 441-453.

Flick, U. (2009). An introduction to qualitative research. London, Sage.

Flygare, S. (2006). The cooperative challenge: Farmer cooperation and the politics of agricultural modernisation in 21st century Uganda. Department of Economic History. Uppsala, Uppsala University. PhD thesis.

Flyvbjerg, B. (2002). Making social science matter: Why social inquiry fails and how it can succeed again. Cambridge, Cambridge University Press.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K. and West, P. C. (2011). "Solutions for a cultivated planet." Nature **478**(7369): 337-342.

Forsyth, T. (2013). Critical political ecology: The politics of environmental science. London, Routledge.

Foster, J. B. (1999). "Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology 1." American Journal of Sociology **105**(2): 366-405.

Francis, P. and James, R. (2003). "Balancing rural poverty reduction and citizen participation: The contradictions of Uganda's decentralization program." World Development **31**(2): 325-337.

Gabrielsson, S., Brogaard, S. and Jerneck, A. (2012). "Living without buffers—illustrating climate vulnerability in the Lake Victoria basin." Sustainability Science **8**(2): 143-157.

Giddens, A. (1984). The constitution of society: Outline of the theory of structuration. Cambridge, Polity Press.

Giller, K., Tittonell, P., Rufino, M. C., Van Wijk, M., Zingore, S., Mapfumo, P., Adjei-Nsiah, S., Herrero, M., Chikowo, R. and Corbeels, M. (2011). "Communicating complexity: Integrated assessment of trade-offs concerning soil fertility management within African farming systems to support innovation and development." Agricultural systems **104**(2): 191-203.

Gilmore, T., Krantz, J. and Ramirez, R. (1986). "Action based modes of inquiry and the host-researcher relationship." Consultation: An International Journal **5**(3): 160-176.

Gladwin, C. H., Buhr, K. L., Goldman, A., Hiebsch, C., Hildebrand, P. E., Kidder, G., Langham, M., Lee, D., Nkedi-Kizza, P. and Williams, D. (1997). "Gender and soil fertility in Africa." Replenishing soil fertility in Africa(replenishingsoi): 219-236.

GoU (1997). District State of Environment Report Tororo. National Environment Management Authority. Kampala, Government of Uganda.

GoU (2000). Plan for Modernisation of Agriculture: Eradicting Poverty in Uganda. A. I. a. F. M. Ministry of Agriculture, and Ministry of Finance Planning and Economic Development (MFPED), . Kampala, Government of Uganda.

GoU (2006). The 2002 Uganda population and housing census: Population size and distribution. Uganda Bureau of Statistics. Kampala, Government of Uganda.

GoU (2007). Report on the Agricultural Module of the 2005/2006 Uganda National Household Survey. Uganda Bureau of Statistics. Kampala, Government of Uganda.

GoU (2008). National Co-operative Development Policy. Ministry of Tourism Trade and Industry. Kampala, Government of Uganda.

GoU (2010a). State of the Environment Report for Uganda 2010. National Environment Management Authority (NEMA). Kampala, Government of Uganda.

GoU (2010b). National Development Plan, 2010/11-2014/15. National Planning Authority. Kampala, Government of Uganda.

GoU (2010c). Water Supply Atlas: Tororo district information. Ministry of Water and Environment. Kampala, Government of Uganda.

GoU (2010d). National Development Plan, 2010/11-2014/15. National Planning Authority. Kampala, Government of Uganda.

GoU (2011). National Agricultural Policy, final draft. Ministry of Agriculture and Animal Industry and Fisheries (MAAIF). Kampala, Government of Uganda.

GoU (2012). Poverty status report: Reducing vulnerability, equalising opportunities and transforming livelihoods. P. a. E. D. Ministry of Finance. Kampala, Government of Uganda.

GoU (2013a). Statistical Abstract 2013. Uganda Bureau of Statistics. Kampala, Government of Uganda.

GoU (2013b). National Budget Framework Paper 2013/2014-2017/18. P. a. E. D. Ministry of Finance. Kampala, Government of Uganda.

Haraway, D. (1988). "Situated knowledges: The science question in feminism and the privilege of partial perspective." Feminist studies **14**(3): 575-599.

Hauser, M., Chowdhury, A. H., Peloschek, F. A. and S.J., S. (2010). "Farmer Participatory Research: An Approach to Fostering Community-led Innovation in Smallholder Agriculture." Journal für Entwicklungspolitik **XXVI** (4): 111-128.

Hawkins, R. and Ojeda, D. (2011). "Gender and environment: critical tradition and new challenges." Environment and Planning-Part D **29**(2): 237.

Henao, J. and Baanante, C. (2006). Agricultural Production and Soil Nutrient Mining in Africa: Implications for Resource Conservation and Policy Development. Background Paper for the Africa Fertilizer Summit, 2006, Abuja, Nigeria. Alabama, IFDC International Center for Soil Fertility and Agricultural Development.

Herr, K. and Anderson, G. L. (2005). The action research dissertation: A guide for students and faculty. Thousand Oaks, SAGE Publications, Inc.

Hickey, S. (2013). "Beyond the Poverty Agenda? Insights from the New Politics of Development in Uganda." World Development **43**(0): 194-206.

Hoben, A. (1995). "Paradigms and politics: the cultural construction of environmental policy in Ethiopia." World Development **23**(6): 1007-1021.

Hovorka, A. (2006). "The No. 1 Ladies' Poultry Farm: A feminist political ecology of urban agriculture in Botswana." Gender, Place and Culture **13**(3): 207-225.

Hovorka, A. (2013). "The Case for a Feminist Foodscapes Framework: Lessons from research in urban Botswana." Development **56**(1): 123-128.

Hubert, B., Rosegrant, M., van Boekel, M. A. and Ortiz, R. (2010). "The future of food: scenarios for 2050." Crop Science **50**(Supplement_1): S-33-S-50.

Hundsbæk Pedersen, R., Spichiger, R., Alobo, S., Kidoido, M., Bashaasha, B. and Munk Ravnborg, H. (2012). Land Tenure and Economic Activities in Uganda: a Literature Review. DIIS Working Paper 2012:13. Copenhagen, Danish Institute for International Studies, DIIS.

IAASTD (2009). Agriculture at a crossroads. Global and synthesis reports. The International Assessment of Agricultural Knowledge, Science and Technology for Development. Washington, DC, Island Press.

IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report Intergovernmental Panel on Climate Change.

Jerneck, A. and Olsson, L. (2011). "Breaking out of sustainability impasses: how to apply frame analysis, reframing and transition theory to global health challenges." Environmental Innovation and Societal Transitions **1**(2): 255-271.

Jerneck, A. and Olsson, L. (2013). "More than trees! Understanding the agroforestry adoption gap in subsistence agriculture: Insights from narrative walks in Kenya." Journal of Rural Studies **32**: 114-125.

Jerneck, A., Olsson, L., Ness, B., Anderberg, S., Baier, M., Clark, E., Hickler, T., Hornborg, A., Kronsell, A. and Lövbrand, E. (2011). "Structuring sustainability science." Sustainability Science **6**(1): 69-82.

Jones, A., Breuning-Madsen, H., Brossard, M., Dampha, A., Deckers, J., Dewitte, O., Gallali, T., Hallett, S., Jones, R., Kilasara, M., Le Roux, P., Micheli, E., Montanarella, L., Spaargaren, O., Thiombiano, L., Van Ranst, E., Yemefack, M. and R., Z. (2013). Soil Atlas of Africa. Luxembourg, European Commission, Publications Office of the European Union.

Joughin, J. and Kjær, A. M. (2010). "The politics of agricultural policy reform: the case of Uganda." Forum for Development Studies **37**: 61-78.

Kabeer, N. (1991). Gender production and well-being: rethinking the household economy. IDS Discussion Paper 288. Sussex, Institute for Development Studies.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B. and Dickson, N. M. (2001). "Sustainability science." Science **292**(5517): 641-642.

Keeley, J. and Scoones, I. (2000). Global science, global policy: local to global policy processes for soils management in Africa. IDS Working Paper 114. Sussex, Institute of Development Studies at the University of Sussex.

Kerkvliet, B. J. T. (2009). "Everyday politics in peasant societies (and ours)." The Journal of Peasant Studies **36**(1): 227-243.

Koning, N. and Smaling, E. (2005). "Environmental crisis or 'lie of the land'? The debate on soil degradation in Africa." Land Use Policy **22**(1): 3-11.

Kottak, C. P. (1999). "The new ecological anthropology." American Anthropologist **101**(1): 23-35.

Kristjanson, P., Reid, R. S., Dickson, N., Clark, W. C., Romney, D., Puskur, R., MacMillan, S. and Grace, D. (2009). "Linking international agricultural research knowledge with action for sustainable development." Proceedings of the National Academy of Sciences **106**(13): 5047-5052.

Kuper, A. (1996). Anthropology and anthropologists: the modern British school. London, Routledge.

Kvale, S. (1996). Interviews: An introduction to qualitative research interviewing. Thousand Oaks, Sage.

Kwapong, N. A. and Korugyendo, P. L. (2010). "Revival of agricultural cooperatives in Uganda." International Food Policy Research Institute Policy Note(10).

Lal, R. (2013). "Climate-strategic agriculture and the water-soil-waste nexus." Journal of Plant Nutrition and Soil Science **176**(4): 479-493.

Lal, R. (2013). Principles of Soil Mangagement. Principles of Sustainable Soil Management in Agroecosystems. R. Lal and B. A. Stewart. New York, CRC Press LLC: 1-17.

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G. and Folke, C. (2001). "The causes of land-use and land-cover change: moving beyond the myths." Global environmental change **11**(4): 261-269.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M. and Thomas, C. J. (2012). "Transdisciplinary research in sustainability science: practice, principles, and challenges." Sustainability Science **7**(1): 25-43.

Leach, M. and Mearns, R., Eds. (1996). The lie of the land: challenging received wisdom on the African environment. African issues. Oxford, International African Institute.

Leach, M., Mearns, R. and Scoones, I. (1999). "Environmental entitlements: dynamics and institutions in community-based natural resource management." World Development **27**(2): 225-247.

Leach, M., Scoones, I. and Stirling, A. (2010). Dynamic Sustainabilities–Technology, Environment, Social Justice. London, Earthscan.

Lewin, K. (1946). "Action research and minority problems." Journal of social issues **2**(4): 34-46.

Lister, R. (2004). Poverty. Cambridge, Polity Press.

Lloyd-Evans, S. (2006). Focus groups. Doing development research. V. Desai and R. Potter. London, SAGE Publications: 153-163.

Magunda, M. K. and Tenywa, M. M. (2001). Soil and water conservation. Agriculture in Uganda. Vol 1: General information. National Agricultural Research Organisation. Kampala, Fountain Publishers Ltd.

Mapfumo, P., Adjei-Nsiah, S., Mtambanengwe, F., Chikowo, R. and Giller, K. E. (2013). "Participatory action research (PAR) as an entry point for supporting climate change adaptation by smallholder farmers in Africa." Environmental Development **5**: 6-22.

Marenya, P., Nkonya, E., Xiong, W., Deustua, J. and Kato, E. (2012). "Which policy would work better for improved soil fertility management in sub-Saharan Africa, fertilizer subsidies or carbon credits?" Agricultural systems **110**: 162-172.

Markelova, H., Meinzen-Dick, R., Hellin, J. and Dohrn, S. (2009). "Collective action for smallholder market access." Food policy **34**(1): 1-7.

Max-Neef, M. A. (2005). "Foundations of transdisciplinarity." Ecological economics **53**(1): 5-16.

Mayoux, L. (2006). Quantitative, Qualitative or Participatory? Which method, for what and when? Doing development research. V. Desai and R. Potter. London, SAGE Publications: 115-129.

Mazzucato, V. and Niemeijer, D. (2002). "Population Growth and the Environment in Africa: Local Informal Institutions, the Missing Link." Economic Geography **78**(2): 171-193.

McCann, J. (1999). Green land, brown land, black land: an environmental history of Africa, 1800-1990. Portsmouth, NH, Heinemann.

McNiff, J. and Whitehead, J. (2010). You and your action research project. New York, Routledge.

Meinert, L. (2009). Hopes in Friction: Schooling, health and everyday life in Uganda, Information Age Publishing Inc.

Meinzen-Dick, R., DiGregorio, M. and McCarthy, N. (2004). "Methods for studying collective action in rural development." Agricultural systems **82**(3): 197-214.

Meinzen-Dick, R. S. and Di Gregorio, M. (2004). Collective action and property rights for sustainable development. 2020 Vision for Food, Agriculture and the Environment, Focus 11. Washington, D.C., International Food Policy Reseach Institute.

Mikkelsen, B. (2005). Methods for development work and research: a new guide for practitioners. New Delhi, SAGE Publications Pvt. Limited.

Miller, T. R. (2013). "Constructing sustainability science: emerging perspectives and research trajectories." Sustainability Science **8**(2): 279-293.

Miller, T. R., Wiek, A., Sarewitz, D., Robinson, J., Olsson, L., Kriebel, D. and Loorbach, D. (2013). "The future of sustainability science: a solutions-oriented research agenda." Sustainability Science: 1-8.

Mills, C. W. (1959). The sociological imagination. New York, Oxford University Press.

Misiko, M. (2009). "Collective Experimentation: Lessons from the Field." Journal of Agricultural Education and Extension **15**(4): 401-416.

Mortimore, M. and Harris, F. (2005). "Do small farmers' achievements contradict the nutrient depletion scenarios for Africa?" Land Use Policy **22**(1): 43-56.

Morton, J. F. (2007). "The impact of climate change on smallholder and subsistence agriculture." Proceedings of the National Academy of Sciences **104**(50): 19680-19685.

Moser, C. (2003). Gender planning and development: Theory, practice and training. London, Routledge.

Mrema, H. A. (2008). Uganda: Starting All Over Again. Renaissance of African Cooperatives in the 21st Century: Lessons from the Field. P. Develtere, I. Pollet and F. Wanyama. Geneva, International Labour Office.

Munk Ravnborg, H., Bashaasha, B., Hundsbæk Pedersen, R., Spichiger, R. and Turinawe, A. (2013). Land Tenure under Transition: Tenure Security, Land Institutions and Economic Activity in Uganda. DIIS Working Paper 2013:03. Copenhagen, Danish Institute for International Studies, DIIS.

Nightingale, A. J. (2003). "A feminist in the forest: Situated knowledges and mixing methods in natural resource management." ACME: An International E-Journal for Critical Geographies **2**(1): 77-90.

Nightingale, A. J. (2011). "Bounding difference: Intersectionality and the material production of gender, caste, class and environment in Nepal." Geoforum **42**(2): 153-162.

Osbahr, H., Dorward, P., Stern, R. and Cooper, S. (2011). "Supporting agricultural innovation in Uganda to respond to climate risk: linking climate change and variability with farmer perceptions." Experimental Agriculture **47**(02): 293-316.

Ostrom, E. (1990). Governing the commons: The evolution of institutions for collective action. Cambridge, Cambridge university press.

Ostrom, E. (2007). "A diagnostic approach for going beyond panaceas." Proceedings of the National Academy of Sciences **104**(39): 15181-15187.

Ostrom, E. (2010). "Analyzing collective action." Agricultural Economics **41**(s1): 155-166.

Oxfam (2008). Turning up the Heat: Climate Change and Poverty in Uganda. Kampala, Oxfam GB.

Pandolfelli, L., Meinzen-Dick, R. and Dohrn, S. (2008). "Gender and collective action: motivations, effectiveness and impact." Journal of International Development **20**(1): 1-11.

Paulson, S. and Gezon, L. L., Eds. (2004). Political ecology across spaces, scales, and social groups. New Brunnswick, Rutgers University Press.

Pauw, K. and Thurlow, J. (2013). Prioritizing rural investments in Africa: A hybrid evaluation approach applied to Uganda. WIDER Working Paper, No. 2013/060. Helsinki, United Nations University, World Institute for Development Economics Research.

Pender, J., Place, F. and Ehui, S., Eds. (2006). Strategies for sustainable land management in the East African Highlands. Washington, DC, International Food Policy Research Institute.

Pender, J., Ssewanyana, S., Edward, K. and Nkonya, E. (2004). Linkages between poverty and land management in rural Uganda: evidence from the Uganda National Household Survey, 1999/00, Intl Food Policy Res Inst.

Peterson, G. (2000). "Political ecology and ecological resilience:: An integration of human and ecological dynamics." Ecological economics **35**(3): 323-336.

Pidwirny, M. (2013). "Soil." The Encyclopedia of Earth. Retrieved 2013-10-18, from http://www.eoearth.org/view/article/156081.

Pohl, C., Rist, S., Zimmermann, A., Fry, P., Gurung, G. S., Schneider, F., Speranza, C. I., Kiteme, B., Boillat, S. and Serrano, E. (2010). "Researchers' roles in knowledge co-production: experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal." Science and Public Policy **37**(4): 267-281.

Pretty, J., Toulmin, C. and Williams, S. (2011). "Sustainable intensification in African agriculture." International journal of agricultural sustainability **9**(1): 5-24.

Pretty, J. and Ward, H. (2001). "Social capital and the environment." World Development **29**(2): 209-227.

Quisumbing, A. (2003). Household decisions, gender, and development: a synthesis of recent research. Washington, DC., International Food Policy Research Institute.

Quisumbing, A. R., Brown, L. R., Feldstein, H. S., Haddad, L. and Peña, C. (1995). Women: The key to food security. Food Policy Report. Washington, DC., International Food Policy Research Institute.

Ragin, C. C. and Amoroso, L. M. (2011). Constructing social research: The unity and diversity of method. Thousand Oak, Pine Forge Press.

Ramisch, J. (2012). 'This field is our church' The social and agronomic challenges of knowledge generation in a participatory soil fertility mangement project. Contested Agronomy: Agricultural Reseach in a Changing World. J. Sumberg and J. Thompson. Oxon, Routledge.

Ramish, J. (2010). Beyond the Invisible: Finding the Social Relevance of Soil Nutrient Balances. Beyond the biophysical: Knowledge, Culture, and Power in Agriculture and Natural Resource Managament. L. German, J. Ramish and R. Verma. London and New York, Springer.

Razavi, S. (2009). "Engendering the political economy of agrarian change." The Journal of Peasant Studies **36**(1): 197-226.

RCDF (2010). PRDF Projects in Tororo District, Uganda. Kampala, Rural Communications Development Fund.

Reason, P. and Bradbury, H., Eds. (2008). Introduction. The SAGE Handbook of Action Research. Los Angeles, SAGE Publications Ltd.

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C. and Raymond, C. (2010). "What is social learning?" Ecology & Society **15**(4).

Reij, C. and Bayer, A. W. (2001). Farmer innovation in Africa: a source of inspiration for agricultural development, Earthscan.

Ribot, J. C. and Peluso, N. L. (2003). "A Theory of Access." Rural sociology **68**(2): 153-181.

Robbins, P. (2012). Political ecology: a critical introduction. West Sussex, Blackwell Publishing Ltd.

Rocheleau, D. (1995). "Maps, Numbers, Text, and Context: Mixing Methods in Feminist Political Ecology." The Professional Geographer **47**(4): 458-466.

Rocheleau, D., Thomas-Slayter, B. and Wangari, E., Eds. (1996). Feminist political ecology: Global issues and local experience. International studies of women and place. London, Routledge.

Rocheleau, D. E. (2008). "Political ecology in the key of policy: From chains of explanation to webs of relation." Geoforum **39**(2): 716-727.

Rossman, G. B. and Rallis, S. F. (2012). Learning in the field: An introduction to qualitative research. Los Angeles, SAGE Publications.

Rotmans, J. (2005). Societal Innovation: between dream and reality lies complexity. Rotterdam, Erasmus University.

Röling, N. (2009). Conceptual and Methodological Developments in Innovation. Innovation Africa: enriching farmers' livelihoods. P. C. Sanginga, A. Waters-Bayer and S. Kaaria, Earthscan/James & James: 9-34.

Salami, A., Kamara, A. B. and Brixiova, Z. (2010). Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities. Working Paper Series No. 105. Tunis, African Development Bank.

Sanchez, P. A. (2002). "Soil fertility and hunger in Africa." Science **295**(5562): 2019-2020.

Sanginga, P. C., Waters-Bayer, A. and Kaaria, S., Eds. (2009). Innovation Africa: enriching farmers' livelihoods. London, Earthscan/James & James.

Scoones, I. (1997). "Landscapes, fields and soils: understanding the history of soil fertility management in southern Zimbabwe." Journal of Southern African Studies **23**(4): 615-634.

Scoones, I., Ed. (2001). Dynamics and diversity: soil fertility and farming livelihoods in Africa: case studies from Ethiopia, Mali, and Zimbabwe. London, Earthscan.

Scoones, I. (2013). Seeing Scarcity: Understanding Soil Fertility in Africa. The Limits to Scarcity: Contesting the Politics of Allocation. L. Mehta. London and Washington, D.C., Earthscan**:** 165-179.

Semalulu, O., McDonagh, J. and Lu, Y. (2003). Bridging research and development of soil fertility management: Practical tools and approaches for better soil fertility management in East Africa, Natural Resources Systems Programme (NRSP) of the UK Department for International Development (DFID).

Shiferaw, B. A., Okello, J. and Reddy, R. V. (2009). "Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices." Environment, development and sustainability **11**(3): 601-619.

Skinner, J., Ed. (2012). The interview: an ethnographic approach. London, Berg.

Smith, L., Bratini, L., Chambers, D.-A., Jensen, R. V. and Romero, L. (2010). "Between idealism and reality: Meeting the challenges of participatory action research." Action Research **8**(4): 407-425.

Steen, K. (2011). Time to farm. A qualitative inquiry into the dynamics of the gender regime of land and labour rights in subsistence farming: an example of the Chiweshe communal area, Zimbabwe. Lund University Centre for Sustainability Studies. Lund, Lund University. PhD thesis.

Stoorvogel, J. and Smaling, E. (1990). Assessment of soil nutrient depletion in Sub-Saharan Africa: 1983-2000. Wageningen, Winand Staring Centre.

Stott, P. and Sullivan, S. (2000). Political ecology: Science, myth and power. London, Arnold.

Sumberg, J. and Thompson, J. (2012). Contested agronomy: agricultural research in a changing world, Routledge.

Susman, G. I. (1983). Action research: a sociotechnical systems perspective. Beyond method: Strategies for social research. G. Morgan. Newbury Park, CA., Sage**:** 95-113.

Swidler, A. (1986). "Culture in action: Symbols and strategies." American sociological review: 273-286.

Thompson, J. and Scoones, I. (2009). "Addressing the dynamics of agri-food systems: an emerging agenda for social science research." Environmental science & policy **12**(4): 386-397.

Tian, G., Kolawole, G., Salako, F. and Kang, B. (1999). "An improved cover crop-fallow system for sustainable management of low activity clay soils of the tropics." Soil Science **164**(9): 671-682.

Tiffen, M., Mortimore, M. and Gichuki, F. (1994). More people, less erosion: environmental recovery in Kenya. Chichester, John Wiley & Sons Ltd.

Tittonell, P., Muriuki, A., Shepherd, K. D., Mugendi, D., Kaizzi, K., Okeyo, J., Verchot, L., Coe, R. and Vanlauwe, B. (2010). "The diversity of rural livelihoods and their influence on soil fertility in agricultural systems of East Africa–a typology of smallholder farms." Agricultural systems **103**(2): 83-97.

Toenniessen, G., Adesina, A. and DeVries, J. (2008). "Building an Alliance for a Green Revolution in Africa." Annals of the New York Academy of Sciences **1136**(1): 233-242.

Tripp, A. M. (2004). "Women's movements, customary law, and land rights in Africa: the case of Uganda." African Studies Quarterly 7(4): 1-19.

Truelove, Y. (2011). "(Re-) Conceptualizing water inequality in Delhi, India through a feminist political ecology framework." Geoforum **42**(2): 143-152.

Turner, B. and Robbins, P. (2008). "Land-change science and political ecology: Similarities, differences, and implications for sustainability science." Annual review of environment and resources **33**: 295-316.

UN (2003). "Uganda United Nations Cartographic Section." Retrieved 2014-04-27, from http://www.un.org/Depts/Cartographic/map/profile/uganda.pdf.

Walker, P. A. (2005). "Political ecology: where is the ecology." Progress in Human Geography **29**(1): 73-82.

Wangari, E., Thomas-Slayter, B. and Rocheleau, D. (1996). Gendered visions for survival. Feminist political ecology: Global issues and local experience. D. Rocheleau, B. Thomas-Slayter and E. Wangari. London, Routledge.

Vanlauwe, B., Bationo, A., Chianu, J., Giller, K., Merckx, R., Mokwunye, U., Ohiokpehai, O., Pypers, P., Tabo, R. and Shepherd, K. (2010). "Integrated soil fertility management operational definition and consequences for implementation and dissemination." Outlook on agriculture **39**(1): 17-24.

Vanlauwe, B. and Zingore, S. (2011). "Integrated Soil Fertility Management: An Operational Definition and Consequences for Implementation and Dissemination." Better Crops: 4.

Vayda, A. P. and Walters, B. B. (1999). "Against political ecology." Human ecology **27**(1): 167-179.

Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. Cambridge, Cambridge university press.

Verma, R. (2001). Gender, Land and Livelihoods in East Africa: Through Farmers' Eyes. Ottawa, Canada, International Developement Research Centre.

Verma, R. (2001). Gender, Land, and Livelihoods in East Africa: Through Farmers' Eye. Otawa, International Development Research Centre.

Whyte, M. A. and Kyaddondo, D. (2006). "'We are not eating our own food here': food security and the cash economy in Eastern Uganda." Land degradation & development **17**(2): 173-182.

Widerberg, K. (2002). Kvalitativ forskning i praktiken. Lund, Studentlitteratur.

World Bank (2007). World development report 2008: Agriculture for development. Washington DC, World Bank.

World Bank, Ed. (2009). Gender in Agriculture Sourcebook. Agriculture and rural developme. Washington, World Bank Publications.

World Bank (2013, 2013-09-03). "Fertilizer consumption in Uganda 2008-2012." Retrieved 2013-09-03, from http://wdi.worldbank.org/table/3.2.