# Subdividing the Savanna: the ecology of change in Northern Tanzania

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctorate of Philosophy in the Curriculum of Ecology.

Chapel Hill
2007

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**ABSTRACT**

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Subdividing the Savanna: the ecology of change in Northern Tanzania
(Under the direction of Paul Leslie)

East African savannas are persistent socio-ecological systems undergoing unprecedented change. This dissertation focuses on the emerging agro-pastoral system of Maasai herders in the savanna lands adjacent to Tanzania's Tarangire National Park. As pastoralists adopt cultivation, the relationship between humans and the land is changed. The new dynamics threaten the resilience of savanna systems. I examine three aspects of the human ecology of Maasai subsistence: changes in territory and political ecology, changes to the local common property system resulting from territorial compression, and how Maasai are responding to the production constraints of cultivation. I employed ethnography, social surveys, soil surveys and livestock demography to take a political ecology approach to investigating human-environment relations.

Maasai territory is being fragmented by forces from within and without Maasai society. Poverty is increasing, due to market integration, high cattle mortality and population growth. Despite this, the adoption of cultivation cannot be explained by poverty alone. Poverty interacts with land tenure insecurity and with environmental stochasticity to create conditions conducive to the adoption of cultivation. Subdivision fragments the pastures which support pastoralism, reducing mobility and flexibility critical to dryland ecosystems. A village zoning plan has led to the emergence of a new common property regime that appears sufficient for current grazing and cultivation needs

yet the historical pattern of land allocation means some villagers have greater access to protected pastures and water than others. Rich soils from abandoned kraals are also unequally distributed across the landscape. Pastoralists must negotiate limited cultivation experience, wildlife raids and labor shortages to integrate pastoral and agricultural production.

Several trends suggest negative repercussions for future resilience of the socio-ecological system. Unequal resource distribution among land allocations, the history of interactions between stakeholder groups, and land use patterns that inadvertently concentrate resources among a few households are decreasing the flexibility demanded by semi-arid systems. To reduce the negative effects of cultivation, efforts should focus on improving yields on small plots, supporting livestock husbandry and integrating local residents and wildlife interests to build a resilient future.

## ACKNOWLEDGEMENTS

Any dissertation is a collaborative effort involving more people than just the writer. A dissertation involving fieldwork and ethnography involves many more, stretching across two continents. I apologize in advance for any names I've left out inadvertently, or misspelled. I will start with the village and then shift home.

First, I must thank the entire village of Loiborsoit for being so generous with their time and lives. They put up with my silly questions and still invited us to parties. Jan Peter Jarl and his wife, Noreteet, graciously allowed us to add on to earlier research camp on their land. Noreteet also led us first to Mama Maria and then to Kisioki Kuya, who became excellent camp staff. "Mama Maziwa," not only brought us milk daily but was a great friend. Johanna Siria and his somewhat crazy extended family were wonderful friends during our stay in Loiborsoit. Special thanks go to the bomas of Kone Ndimmu, Lopasio Kipaha, Ng'esee Leleshwa, all of the bomas down near the handpump in Olmotoo (Madawa, Leshagga, Mosson, etc), and the extended Shinini clan for making our stay in Loiborsoit enjoyable.

My assistant, Isaya Ole Ramos, and his entire family were wonderful neighbors. Isaya showed up 6 days a week supporting my progress in Kiswahili through Scientific Argument. His family kept rainfall records for me, and both his sister Monika and brother the Mwalimu provided a welcome relief from Kimaasai. I also thank Samson and Jumanne for their assistance surveying fields. Their amusement over the tasks I set

continues to amuse me in return. Partimbo Tendee, Leyan (of Mtendaji fame), Loltukai, Nengeliai Koney, Saningo Mpashi and the rest of the village and sub-village governments were invaluable in giving me permission to conduct research in Loiborsoit but also generous with their time when I had questions. Thaddeus Orpiay assisted me in organizing the livestock census. It went much more smoothly with his help.

In searching for a study site, all of the Simanjiro and Monduli District and Officers were very helpful, but Claudy Losioki, Assistant District Agricultural Officer of Simanjiro was particularly welcoming. In Arusha, Patricia Moehlman helpfully led us to Abe Sulieman of Tuckman mines. Abe, or rather his incredible staff, were instrumental in finding us a vehicle during high season and an apartment in the city. The library and staff of the African Wildlife Foundation were very helpful, particularly Dr. James Kahurananga. Peter Toima, formerly of Inyuat e maa first introduced me to Loiborsoit. Dr. Ngatoluwa and his staff at the Soils Laboratory of the Selian Agricultural Institute were wonderful to work with, efficient and quick.

In Dar es Salaam, I thank COSTECH for giving me clearance to do research in Tanzania. At the University of Dar es Salaam, Professor R. B. B. Mwalyosi and Dr. Sosovele were very helpful in obtaining research clearance with a minimum of fuss. The American Embassy was fabulous in helping us get our visas through immigration, a favor I very much appreciate. Haji O. Suliemani, of the National Herbarium in Dar, helped me identify hundreds of grass and herbs over the space of a week, taking the time to explain the fine differences between grass species.

We also had great network of American friends who kept us from going crazy. Mara Goldman, Lauren Persha, Stacy Lynn, Anna Estes, Brian Doench and Paula

Gremley were great company both in town and as visitors at our boma for holidays. In Dar es Salaam, Ned Bertz and Joy Baumgartner were, and remain, fantastic friends.

The government of the United States of America has most generously paid for nearly all of my time overseas, beginning with the Peace Corps—yet another reason to hang my flag out on the Fourth of July. My dissertation field work was funding by a Fulbright-Hays Doctoral Research Abroad Fellowship through the U.S. Department of Education and a Dissertation Improvement Grant from the National Science Foundation through their offices of Geography and Regional Science Program and the Africa Program in the National Science Foundation's Office of International Science and Engineering. UNC's University Center for International Studies (now the Global Education Center), supported both pre-dissertation research and language study through a Summer Travel Grant and a Foreign Language and Areas Studies (FLAS) grant. The American Association of University Women (AAUW) funded the first year of write-up, immediately following the return to the western world. Finally, the Curriculum in Ecology assisted me in finding many teaching opportunities to help fund my time in Chapel Hill, sometimes when I hadn't even counted on it.

In North Carolina I must thank my committee: Paul for not letting me quit and being incredible with finding (and getting) funding, Seth for cheerleading, Peter for fantastic explanatory emails, Tom for reminding me of the big picture and Melinda for believing in me at the very beginning when I needed to be believed in. Major thanks to all the admin folks the Curriculum has had over the years: Cottie Pasternak, Karen Hunt and Denise Kenner. Jack Weiss, the stats guru, does a great job of pulling information out of data I thought was a lost cause. Although they are not at UNC, Lew Lama of

Viterbo University, Peter Rogers, recently of Bates College and Jim Igoe and Terry McCabe of the University of Colorado, Boulder have been sources of information and interest in my work that has helped me push on at various times.

I have a strong network of friends who have helped along the way: Brandie and Barker Fariss, Mary James Stevenson, Chris Brooks, Allison and Alan Weakley, Janet Peterson, Rebecca Asbury, Reba Vidra, Eileen Vandenburgh, Dane Kuppinger, Flora Lu, Greg Gangi and others I know I'm forgetting. Janice Howard has been a great babysitter throughout the last few years, allowing me to work knowing my daughter was happy. The online community, Phinished, helped me start writing around a toddler. Its helpful to know someone is working when you are—even at 3am! Special thanks go to Mara and Brandie. I probably never would have made it through without them. Our collaborative discussions and mutual encouragement have supported me throughout this process

I'd like to thank my family for putting up with this seemingly unending dissertation. My parents, John Cooke, Patricia Essex and Mark Asman, were sources of financial and emotional help as they have all been through the process of graduate education. Thanks for raising me to ask questions. My parents-in-law, Cheryl and Jim Eyster, came to North Carolina a number of times to help with Iris so I could focus on work. Helen Maddock assisted with finances but was also an example that women can be scientists. I hope she finds this dissertation worth reading!

Finally, I must thank my husband, Darin Eyster, for his (over-extended) patience, willingness to move across the planet for two years and excellent grasp of logistics. Without Darin, my life in Loiborsoit would have been more austere than necessary, even in a mud hut. Because he was with me, my car ran, I ate fantastic meals in the bush, and

I had an entry into the lives of many Maasai and Dorobo families I would have otherwise missed. My daughter Iris Skye, born during the process, has also had to put up with a lot this last year. Yes, Iris, I'm finally done with my dissertation

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| | |
|---|---|
| AWF | African Wildlife Foundation |
| CGIAR | Consultative Group on International Agricultural Research |
| CIAT | International Institute for Tropical Agriculture |
| CPR | Common Pool Resource |
| NCA(A) | Ngorongoro Conservation Area (Authority) |
| NIC | National Investment Centre |
| NGO | Non-Governmental Organization |
| TANAPA | Tanzania National Parks Authority |
| TCP | Tanzania Conservation Project |
| TAWIRI | Tanzania Wildlife Research Institute |
| TME | Tarangire-Manyara Ecosystem |
| TNRF | Tanzanian Natural Resources Forum |
| SARI | Selian Agricultural Research Institute |
| SCA | Simanjiro Conservation Area (proposed) |
| SES | Socio-ecological system |
| URT | United Republic of Tanzania |

# CHAPTER 1

## INTRODUCTION

### INTRODUCTION

The savannas of East Africa are rich in exotic views, teeming wildlife and intriguing traditional cultures. Even within the general fascination the West has with the 'otherness' of Africa, the savannas have a special hold on our imagination. This is clearly evident in our media; lions and elephants populate nature documentaries[1], Maasai herdsman sell credit cards on television—and what child's picture book of animals would be complete without a tall, cool giraffe picking off leaves from a flat-topped acacia tree?

Despite our image of the endless savanna with its huge wildlife migrations and unchanging traditional cultures, the grasslands of East Africa are the site of intense transformation. On the plains, tourists and wildlife, herders and immigrant farmers intermingle. These interactions alter the structure and nature of this ecozone, subdividing its open space, settling people permanently in areas only lightly inhabited for millennia (Borner 1985, Igoe 2004, Mwalyosi 1992, Galaty 1993). The conversion of open grassland into farms and settlements is of huge interest to conservationists and ecologists interested in species conservation (Lamprey and Reid 2006, Mwalyosi 1994, Western and Gichohi 1993, NELSON 2005, Homewood et. al. 2001), hunting and safari enthusiasts (*Endeleza Hifadhi* 2004, Nelson 2005, Kidegesho et al. 2000), social scientists (Igoe and

[1] Lions are so pervasive in nature documentaries that I once watched a documentary about a photographer trying to film a lion kill for another documentary. There was not a lot of action.

Brockington 1999, Thompson 2002, O'Malley 2000, Ndagala 1996, 1997, Fratkin 2001) and indigenous rights activists (Igoe 2003, Hodgson and Schroeder 2002, Parkipuny 1991). The divide in interests, language and goals is wide: attempts to bridge these differences and craft compatible policies have begun but are hampered by a dearth of data in critical areas (Igoe 2004, NELSON 2005).

The trend towards subdivision and settlement of open areas is hardly limited to eastern Africa. Worldwide, grasslands are being converted from communally held resources to subdivided and individualized parcels of land (Fratkin and Mearns 2003, Banks 2001). Yet in East Africa we are faced with the distracting image of a Maasai warrior plowing the plains. For a people who are defined in the world's mythology as "intrepid warriors" (Perlez 1999, Hodgson 2001), who define *themselves* as People of the Cattle (Spear 1993), the image of a Maasai losing his spear and hitching those Cattle to an ox-plow is discordant. The questions this change brings to mind are endless—why would the Maasai do such a thing? How has this changed their lives? Do they no longer care about livestock? What does it mean for the wildlife with whom we, the West, imagine them living in harmony?

The fieldwork described in this dissertation was undertaken in order to answer some of these questions by examining the human and political ecology of the evolution of this savanna production system. This dissertation addresses a subset of questions tied together through an investigation of how the relationship between Maasai and their territory is changing, each focused on a different aspect of change in Maasailand ecology. Specifically, the three questions it attempts to answer are: *Why have Maasai chosen to take up the plow (and tractor)? How has the addition of cultivation to their subsistence*

*strategy modified the use and ownership of the rangelands? How are the Maasai, as new farmers, dividing and managing their smaller, individualized territories?*

## STUDYING HUMAN-ENVIRONMENT DYNAMICS

Examining the dynamics of human-environment relationships requires an interdisciplinary perspective and a diverse methodological toolbox. My field research combined methodologies from geography, plant ecology, anthropology and geography in order to examine the related dynamics of human and environmental change in the Maasai production system. In particular I have been influenced by human and political ecology and the ecological concept of resilience, especially as it relates to integrated socio-ecological systems.

In general, biological ecologists consider humans to be a disturbance within the system. Social scientists have frequently been wary of examining the influence of environmental processes on human organization for fear of being labeled environmental determinists. I do not believe a true understanding of landscape dynamics can be achieved without examining both natural and social science ecology. Even landscapes that appear to be 'pristine' and natural through Western eyes are nearly always impacted and modified by humans. African savannas are a prime example. The line between what is natural and unnatural in landscapes which have had humans for at least 50,000 years is clearly arbitrary. I choose to consider these landscapes, and indeed all working landscapes, as socio-ecological systems. Berkes and Folke (1998) define socio-ecological systems (SES) as linked social and ecological systems. The past 35 years have seen an increased interest in studying the links between society and the environment, leading to an explosion of subfields directed at the issue (Berkes 2004). These include

the study of common property systems (Ostom 1999, Dietz et al., 2003), human ecology (Little and Leslie 1999), traditional ecological knowledge, environmental ethics, political ecology, environmental history (Cronon 1983, Crosby 2004), ecological economics (Costanza 1996), farming systems research (Brush and Turner 1987, Pannell 1999). A key thread tying these disparate subfields together is an appreciation for the complexity of human-environment dynamics and the need for an interdisciplinary toolbox of perspectives and methods to tease out landscape history and management possibilities. A second key concept is that the solutions to environmental problems are not purely technical but require an understanding of local social context for success.

My approach to the study of socio-ecological systems integrates many of these sub-fields. In particular I am influenced by the loosely bound group of methods and theory known as political ecology, but also involving behavioral human ecology, common property and farming systems research. Political ecology is an appropriate lens through which to examine land use change in pastoralist savannas as it touches on so many of the major themes of the literature. The impact of globalization on rural livelihoods, land tenure insecurity and the influence of western style conservation are all issues important to the field. The example of protected areas located in former territories of East African pastoralists is a classic example of the disconnect between traditional wildlife preservation ("Fortress Conservation") and ecosystem functionality (Zimmerer 2000). Robbins (2004) describes four overlapping arguments in contemporary political ecology which all touch on the research described in this dissertation (Table 1.1). The first 3 topics, degradation, issues of conservation and control, and environmental conflict, particularly speak to both the reasons outsiders are particularly interested in land

**Table 1.1 Four central theses in contemporary political ecology (summarized from Robbins 2004)**

| *Topic* | *Description* | *Related chapter* |
|---|---|---|
| Degradation and marginalization | State intervention leads to the transformation of environmentally benign local production systems into unsustainable resource practices. Decreases the resilience of formerly resilient socio-ecological systems. | 2, 3 & 4 |
| Conservation and control | Control of resources has been taken from local land managers in order to preserve the "environment". In order to accomplish this appropriation of resources, state and international authorities frequently recharacterize sustainable land use as unsustainable. | 2, 4 |
| Environmental conflict | Resource enclosure or appropriation by state authorities, private firms or local elites leads to resource scarcity and increased conflict between groups. Environmental problems become 'politicized' and existing social conflicts become 'ecologized' by changes in national policies. | 2 & 3 |
| Environmental identity and social movement | Changes in environmental conditions and management regimes create opportunities for local groups to become politically active and unified across class, ethnicity and gender boundaries. Social/environmental conditions modify powerful global forces. | 2, 3 & 4 |

transformation in the savannas and how pastoralists respond to such concerns. These topics wind their way through the papers of this dissertation, tying them together as a single narrative.

The biophysical landscape resulting from cultural and political decisions creates the context for future debates over equality, development and the utilization of natural resources. The new landscapes being created today are the results of an entire history of political and cultural decisions, both by individuals and societies. The ability of developing landscapes to adapt to these changes without a collapse of ecosystem processes and a reorganization of energy and relationships is called *resilience* (Holling and Gunderson 2002). This concept of resilience has been very influential in the way I

have conceptualized the dynamics operating in Simanjiro. Ecosystem change is seen as a cycle consisting of the exploitation and conservation of resources, during which elements of the socio- ecological system become increasingly connected and brittle, followed by a release point when the system breaks down and then reorganizes before another, new exploitation phase is begun. The ability of a system to withstand changes in this cycle without fully shifting into a new stable state is ecosystem resilience.

### PASTORALISM AND SAVANNA ECOLOGY

Pastoralism is a mode of subsistence based on herding livestock and found all over the world. In East Africa, pastoralist herds consist of cattle, sheep, goats, and, in the drier zones, camels (Figure 1.1). The ratio of species herded depends on cultural

**Figure 1.1 A Maasai junior elder (center) with his family and cow during the early rainy season**. His sister is milking the cow, collecting the milk in a beaded gourd. The children are relatives who live in the same boma. The boys are responsible for much of the day to day herding, particularly during the rainy season when livestock do not have to travel far from the boma: when livestock must travel, the warriors, ilmurran, are in charge of livestock herding and safety.

preferences, environmental parameters and the personal idiosyncrasies of the herders themselves. There is a distinct ecological rationale behind livestock herding: pastoralism has been particularly successful in allowing humans the means to survive in marginal areas (Little and Leslie 1999). Livestock are able to convert grasses inedible to humans into milk and meat that people consume. This conversion of non-human to human food can occur in locations far too marginal for cultivation through the application of intense place-based ecological knowledge. It is not necessary that pastoralists live in extremely arid environments: portions of the African highlands are inhabited by pastoralists who chose to pursue a pastoral lifestyle. However, in time of drought, disease or population pressure pastoralists can survive where agriculturalists cannot.

Pastoralists tend to fall into two camps, nomadic or transhumant. Both grazing systems are intimately tied to the landscape but nomadism involves higher mobility and is found at drier locations on the pastoral spectrum. In these locations rainfall seriously limits biological productivity and herders move where it rains, wherever that might be. Transhumant herders, on the other hand, cycle through a given territory most years. Mobility is still critical—rainfall seldom covers an entire region in semi-arid regions—but the spatial needs are somewhat less because primary productivity, the biomass produced by forage species, is greater. This focus on mobility in pastoralism allows vegetation to recover before being used again. When pastoralists become sedentary, this recovery period is lost, a potential disaster in fragile dry environments (Nyamir-Fuller and Turner 1999). Early observations by Western cattle breeders and specialists felt pastoralism was an inherently destructive production system (Hoben 1976, Homewood and Brockington 1996). Drylands have been shown to be damaged by permanent

habitation, both through human use and the increase in livestock density without a recovery period (Illius and O'Connor 1999). Other research suggests this degradation is reversible with the re-introduction of recovery periods into the grazing cycle (Cingolani et al. 2005, Behnke and Scoones 1993, Ellis and Swift 1988).

In East Africa, most of the most celebrated wildlife preserves are located on rangelands formerly inhabited by herders. Because the ecosystem is so well suited to grazer ecology, both wildlife and pastoralists used similar strategies for survival. The same nutritious wet season grazing lands which support the massive wildebeest migrations in Tanzania are also important grazing for herders. In the more arid northern reaches of East Africa, rainfall is so scarce that the flush of forage produced by scattered rainfalls is quickly exploited by people and wildlife. The grasslands themselves are partial relics of human habitation; first hunter-gatherers increased wielded fire, pastoralists added additional grazers to ranges evolved to handle high levels of grazing and fire regimes (Dublin 1995, Cingolani et al. 2005).

Still, savanna ecology is impacted as much by what pastoralists have *not* done as by their day-to-day production activities. They seldom kill wildlife for food (Jacobs 1965). Few animals are killed to protect the pastoral production system. While wild carnivores do take a percentage of livestock production (Lama 1998), livestock and the majority of wildlife can inhabit similar spaces. When conflicts arise, as in the bovine disease malignant catarrhal fever carried by wildebeest, pastoralists usually choose avoidance instead of removing the wild grazer (McCabe 1994). Pastoralists may have impacted movements of cultivating groups, limiting the encroachment of agricultural fields on the plains. Finally, until the advent of colonialism and the imposition of

boundaries by European colonial powers and later independent African nations, herders didn't subdivide the savannas. The boundaries established since colonialism—created for wildlife preservation, to carve settler ranches or commercial farms, and to resettle growing populations—have altered the way herders are able to interact with their landscape. This has forced changes in all aspects of their production system, impacting both the human and wildlife ecology of the savannas.

### *A brief history of pastoralism in East Africa*

The first residents of eastern Africa were hunter-gatherers whose language was probably a part of the Khoisan language group[2]. Pastoralism came into the region about 5000 years ago when agro-pastoral Cushitic people from modern-day southern Ethiopia moved to the Lake Turkana region of Kenya and adapted their farming system to the arid rangelands (Galaty 1993). Over the next 2000 years these herders moved south onto the productive plains in the Rift Valley and northern Tanzania, developing ties with the hunter-gatherer communities already living there (ibid., Spear 1993). During this period another group of agro-pastoralists, Nilotes from southern Sudan, were settling west of the Rift Valley (ibid). East Africa was then dominated by these three groups, two agro-pastoralist and the early hunting peoples, until the first millennium AD. Fire would have been an important tool for all of these groups and probably helped shape and maintain the character of the landscape even at this early date. It is possible these early herding people

[2] There are four main language groups in Africa: Cushitic languages originating in Ethiopia, Nilotic languages originating in Sudan, Bantu languages originating in West Africa, and the Khoisan (click) languages which were once widespread but now mostly found in southern Africa. Central Tanzania (including the research site) is one of the few places (maybe the only) where all four language groups are represented.

eventually reached as far south as central Tanzania, certainly they reached the Crater Highlands[3] of northern Tanzania relatively early (Sutton 1993).

A second wave of Cushitic-speaking agro-pastoralists joined Bantu farmers migrating into the highlands and the ancestors of the Maasai, Nilotic-speakers who moved into Kenya from the Sudan several thousand years after the first wave (Spear 1993, Sommer and Vossen 1993). There is debate about dates and the configuration of movements, but at some point, possibly as late as 300 years ago (estimates differ), the early Maa-speakers moved into Tanzania, absorbing or pushing off pastoralists from earlier migrations onto poorer rangelands in the move south. In time, these groups formed cultural and kinship ties, separating along food production strategies into herders, farmers and hunters but with mutually advantageous linkages which helped the different groups mitigate risk. Sutton (1993) suggests a 'pastoral revival,' an increased attentiveness to a purely pastoral way of life and the development of the anti-cultivation ethos encountered when Europeans first encountered the Maasai in the late 1800's. It is possible the idea of what it meant to be 'Maasai' migrated more quickly than actual individuals, absorbing older agro-pastoral groups into the Maasai ideology and culture[4]. In any case, it appears that the 'old pastoralism' incorporated mixed herds of smallstock and non-humped pre-zebu cattle with cultivation of some grains (Lamphear 1993). Early Maasai themselves may also have practiced mixed animal and crop husbandry but it seems the idea of the Maasai arose about the same time as specialization in livestock

[3] The Crater Highlands are a string of volcanic calderas and plains which include Ngorongoro Crater Conservation Area.

[4]This discussion is necessarily fluid and difficult to pin down as it is based on limited archeological evidence and linguistics. For more on the debate, see Spear and Waller 1993 and Jennings 2005.

By the mid-nineteenth century the Maa-speaking territory reached from Lake Turkana in Kenya, through the Rift Valley and down into central Tanzania (Galaty 1993). The speakers utilized a range of production strategies, some cultivated and others hunted while others practiced a highly specialized form of pastoralism typified by the Maa-speakers in southern Kenya and Northern Tanzania. These groups formed complex kinship and trading links with each other. The drier grasslands exploited by the Maasai and earlier groups have probably always lent themselves to a more livestock-based economy because cultivation is a risky endeavor but in times of famine it is useful to have relatives in the mountains with crops who can help you, just as it is useful for those farmers to have access to herders on the plains who can hold onto extra animals, storing wealth without losing cropland to pasture. Some have questioned whether it is even possible for specialized pastoralism to develop without access to grains through cultivators (Galaty 1993). It is clear that Maasai have been willing to both farm and hunt when the situation warranted, as in times of drought and disease, but the production systems have largely been separated by environment under good conditions, albeit with fluid social boundaries (Sutton 1993, Galaty 1993, Spear 1993).

Few studies of the human ecology of emerging Maasai agro-pastoral systems have been done. For Tanzania, O'Malley (2001) examined the cultural ecology of livelihood diversification in Loliondo District, Tanzania and concluded that the Maasai sections in the area were diversifying in order to support a more generalized pastoralism. Conroy (2001) focused on the transfer of ox plow technology from local cultivators to Maasai herders and the sustainability of this venture in Kisongo, while Schade looked at the economics of tractor cultivation (1997) and Lama (1998) surveyed the spectrum of

land uses and users in Loiborsoit. My study, coming on the heels of these researchers, takes a different approach by integrating ecologies across the social sciences while maintaining links with the natural ecological sciences. These other studies were also all based on field research in the early days of Tanzania's experiment with economic liberalization and multi-party politics. My study takes place after the initial investment bloom had worn off, providing a snapshot of the next phase in Maasai diversification, especially in a system with easy access to mechanization.

***Simanjiro***

Simanjiro District is in southern Maasailand and dominated by the Kisongo section of the Maasai (Figures 1.3 & 1.4). As in many other areas of pastoral territory, Simanjiro is critical to both Maasai herding systems and wildlife populations. Interest in the Simanjiro system is currently high; at least four studies were begun in the region during or soon after this study was completed. Stakeholder interest is also high; conservation groups, Maasai activists and land hungry agriculturalists have all invested their futures in the region. Their varied interests and projected futures are both deeply intertwined and disputed, leading to extreme tension and frequent altercations. This has culminated in a 2006 moratorium on new farm allocations within Loiborsoit and Emboreet villages (AWF 2006). Even though the overall area of small herder-farmer fields is still low in Simanjiro (Nelson 2005), the concern over the development of an agro-pastoral landscape in Simanjiro makes this an appropriate and interesting study for conservation organizations, rural development specialists and academics interested in pastoralist research, comparative farming systems and household diversification.


**Figure 1.2 Kenya and Tanzania, the countries of East Africa which encompass Maasai territories**

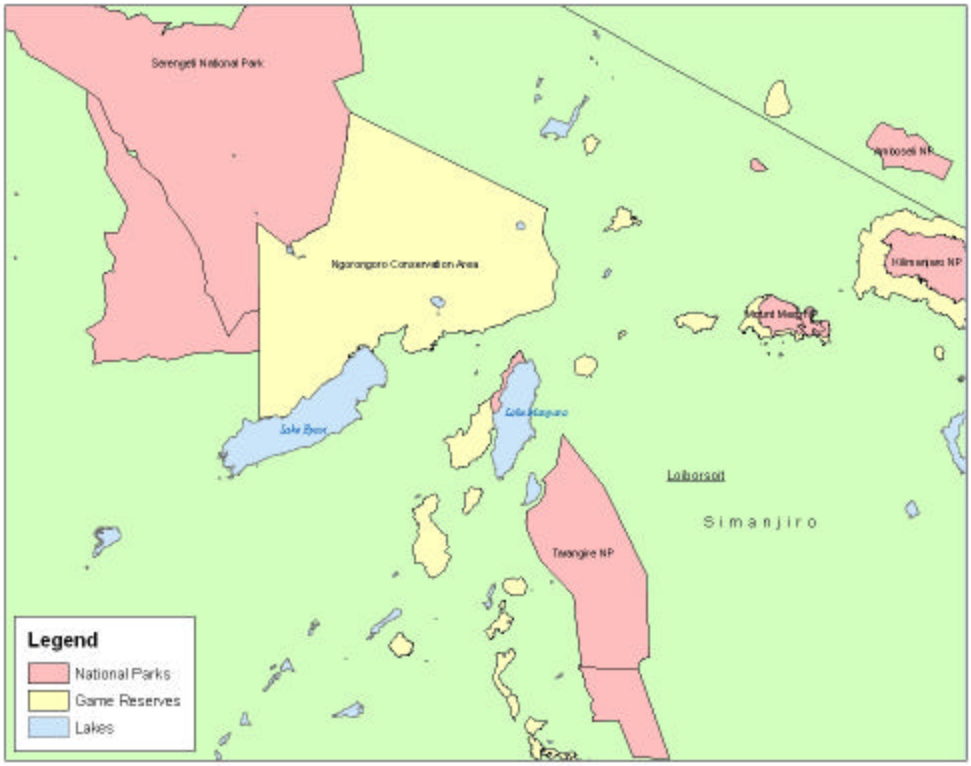



**Figure 1.3 National park and game reserves of northern Tanzania.** Note Simanjiro, the study area, to the east of Tarangire National Park (TNP). Loiborsoit village is located in the northern portion of Simanjiro District. Village boundaries reach to the park boundaries. Of all the protected areas shown, only the mountain parks (Meru and Kilimanjaro) fall outside of traditional Maasai territory. In Kenya the appropriation of pastoral rangelands for conservation is even more extensive. The Tarangire - Manyara Ecosystem (Chapter 2) includes TNP, Simanjiro and Lake Manyara National Park, shown in pink along the northern edge of Lake Manyara. The area is the watershed for Tarangire River (not shown), which runs North-South through TNP. Data source: ILRI

Despite the broad interest in the dynamics of land use change in the region, when I first arrived in Tanzania to conduct fieldwork, I was advised by one conservation organization *not* to go to Simanjiro, despite intense concerns over land use dynamics in the District. In April 2001, an especially tense 'stakeholder' meeting was held between the Tanzanian National Park Association (TANAPA). During this meeting, the subject of remittances for crop losses to wildlife was brought up by a (non-Maasai) resident of Simanjiro District. TANAPA refused to consider the question and the meeting ended in turmoil. After this meeting, the tension between African elites and Western expatriates on the one side and rural Tanzanians on the other escalated: by June 2001, wildlife researchers and many NGOs had either pulled out entirely from the eastern Tarangire area or had lowered their profiles considerably. I was told that the situation was sufficiently tense that I might be threatened or hurt if I insisted on undertaking research on the interactions between wildlife and cultivation. While this is still necessary research, I had enough questions about the evolving agro-pastoral system that I was able to easily refocus my efforts. In any case, by avoiding conservation organizations and working with the government structure, I was able to obtain the necessary approvals to work in Simanjiro. In fact, I found the study village, Loiborsoit, to be unbelievably welcoming, especially given the nervous first few months in Tanzania.

**DISSERTATION ORGANIZATION**

The huge herds of migrating wildebeest are an integral part of Maasailand ecology. Yet for the Maasai, they are just another variable to contend with in a risky world. This dissertation focuses on three important aspects of change in Maasai subsistence: changes in territory and political ecology, changes to the herding system

resulting from territorial compression, and the integration of cultivation into their production system. Together, these chapters describe how and why Maasai are creating a new agro-pastoral landscape on the savanna.

**Chapter 2** examines land subdivision itself. The transformation of Maasai herders into cultivating agro-pastoralists is a subject of interest, both theoretically and practically. This chapter examines two hypotheses which have been proffered for the Simanjiro situation: changing economic realities and land tenure insecurities. At the household level, the reasons household heads chose to begin farming in Loiborsoit are combined with current and historical wealth indicators to examine the role of poverty and population growth in livelihood diversification and its accompanying landscape subdivision. Land tenure insecurities, on the other hand, are largely acted upon at the village level. Ethnographic and historical evidence is offered to support the hypothesis that pressures by the wildlife preservation industry and both small-scale and large scale cultivators searching to expand are all seen as competitors for land and the threat of land loss has pushed Maasai in the village to subdivide in order to claim their land. These two forces, poverty and land tenure insecurity have acted in concert during specific periods of drought and national economic insecurities to hasten the spread of land allocation, a process that is ongoing and increasingly contentious in the District.

The impact of land subdivision on the common pool resource regime in the village is examined in **Chapter 3**. How has the change in lifestyle and subdivision impacted grazing resources? Both livestock and wildlife depend on large grazing areas to survive in this ecosystem. As land has been parceled out, the traditional grazing and resource regime has had to shift to accommodate new land usage. While in the past

Loiborsoit land was good grazing only during the wet season and Maasai moved off of the plateau during the dry season, the creation of Tarangire National Park around historical dry season pastures and drought reserves has forced Simanjiro Maasai to remain on wet season pastures all year around. In this chapter I compare historical grazing patterns and common property regimes with the current mosaic of official grazing pastures, traditional pasture reserves and individually held land.

Pastoralists are experienced in mitigating risk with respect to livestock herding in semi-arid environments. In Chapter 3, I described how they have attempted to restructure their herding patterns to mitigate risk after the loss of critical pastures. In **Chapter 4**, I address farm management of Maasai herder-farmers. In particular, I am interested in how Maasai react to the constraints placed on cultivation. Rainfall, soil attributes, skill levels and wildlife predation are all considered as stressors on the emerging agro-pastoral landscape. Because soil erosion and degradation receive considerable attention by development and conservationists concerned with sustainability in Simanjiro (see NELSON 2005), I focus part of this chapter on an analysis of soil characteristics in Loiborsoit. Both wildlife and soil attributes, largely water holding potential, have influenced agricultural patterns in Loiborsoit. In general the soils are relatively nutrient rich, particularly in phosphorus, but moisture availability is an issue and knowledge of farming management is limited. Additionally, traditional land use patterns, land allocation and the usual trajectory of field expansion may be exacerbating a situation of haves and have-nots, differentiating between those in power, and interested in diversification, during the initial subdivision process and those who gained their land allocations at later dates. Recently, new policies have been enacted banning cultivation

on the plains. The plains are preferred for maize production because of high moisture holding soils and fewer crop raiding wildlife. These new policies are likely to increase tensions throughout the village.

Finally, **Chapter 5** will conclude the dissertation by linking the chapters with important themes from the text, in particular, the importance of history both in current land use patterns and for future ecological and social sustainability. These major themes include the role of conservation initiatives in actually promoting the cultivating landscape and the many ways these changes may be upsetting the long term resilience of the socio ecological ecosystem. The savannas of Simanjiro are currently still very viable but the trajectory of change is troubling. Highly variable ecosystems force user groups into mobile lifestyles with large territories. Fragmenting these landscapes into human enforced boundaries decreases the flexibility of the system, introducing a brittle quality counterproductive to long term sustainability. I conclude with a series of recommendations to both improve local understanding of cultivation's impacts on environment and personal finances, improving livestock keeping skills within the context of the new territorial realities and supporting flexibility in semi-arid regions of East Africa which support both humans and wildlife.

**A note about names and terms:** Maasai is the current correct spelling and is used except in the cases where the earlier spelling was published, i.e., Masai Reserve. The Maa-language has been written by a number of linguists for the Kenyan sections (see Mol 1996). However, the dialect of the Kisongo sections can be significantly different from Kenyan Maa-dialects and I always choose spelling reflecting the Kisongo version of a word. Alternative spellings are frequently used for place names. I have chosen to use

those most frequently encountered during the study period. Thus Emboreet village can be found in other texts as Emboreti, Imboret, Emborret, etc.

*Herder-farmer, agro-pastoralism, mixed farming:* These terms refer to an overlapping continuum of intensification and integration between pastoralism and cultivation. The first refers to herders who farm, the second to farmers to herd and the third to farmers who integrate the resource pathways between cultivation and livestock within a single farm, increasing overall efficiency. Hopefully the difference between the first two terms will come clear though the dissertation.

**Figure 1.4 The Simanjiro Plains hosts the wet season pastures for migratory herbivores, such as this zebra (May 2003)**. Concern over the loss of these lands to cultivation drives much of the antagonism between TNP and Simanjiro pastoralists.

# CHAPTER 2

## PLOWING THE PLAINS

### INTRODUCTION

Pastoralists worldwide are radically transforming their food production system by decreasing their dependence on livestock and mobility, and through the diversification of local economies. Despite this, the literature of agricultural transformation largely focuses on the intensification processes of cultivators (see Boserup 1965, Boserup and Schultz 1990, Netting 1993, Tiffen et al. 1994, Stone 1996, Brookfield 2001). The two processes appear to be very different: while agriculturalists invest in a similar lifestyle, pastoralists seldom intensify their livestock production system (i.e., ranching). Instead, there has been a widespread adoption of cultivation—a move entailing a total rearrangement of landscape patterns, lifestyles and skills (Niamir-Fuller and Turner 1999, Anderson 2002, Campbell 1993, Fratkin 2001). While development agencies and government entities frequently may see this as a positive step, ecologists have been concerned about these changes for many years (Talbot 1973). Given that pastoral lands frequently abut protected areas worldwide (i.e., Homewood and Rogers 1991, Homewood and Brockington 1999, Anderson and Grove 1987 for Tanzania, Homewood 2004, Campbell et al. 2000 for Kenya, Robbins 1998 and 2000, Saberwal 1996 for India, Turner 1999 for Niger), and the spatial incompatibility of wildlife and agricultural areas, the adoption of cultivation into pastoral subsistence is extremely relevant both the conservation and

development communities. It is therefore important to examine the reasons behind the less explored transformation of pastoralists into farmers, or herders who farm, particularly the relative roles of poverty and conservation activities, in order to craft effective land-use strategies for the future.

One pastoral people actively adding cultivation to their subsistence system are the Maasai of East Africa. The Maasai are frequently viewed as the archetypal pastoralists (Spear 1993a). Some claim they have historically disdained cultivation because plowing the land destroys the resource base—pasture—that their subsistence system depends upon (ibid.). Why then, are they subdividing the land and plowing their own pastures? In this chapter I investigate the reasons for this drastic turnaround in the acceptance of cultivated agriculture, both at the village and individual levels.

The Maasai Steppe in the central area of Tanzanian Maasailand has historically been occupied by pastoralists and encompasses rich pastures critical to the survival of wildlife populations migrating from Tarangire National Park during the wet season. Alarm over human occupation of the region has intensified periodically over the past 25 years (Borner 1985, Mwalyosi 1991, 1992a, 1992b, Igoe 2004). Most recently these concerns led to a moratorium on new land allocations in July 2006 (AWF 2006). Two main hypotheses for the adoption of cultivation on the Steppe have been articulated: 1) increasing impoverishment has forced pastoralists to adopt cultivation or rent lands to cultivators to obtain food or cash, and 2) uncertainties over land tenure incite Maasai to plow in order to lay claim to the land (Nelson 2005). Conservation interests have noted that both hypotheses appear to be influencing the landscape and have called for more evidence to understand the dynamics within each village (Nelson ibid.). This chapter

attempts to address these gaps for the village of Loiborsoit at the northern edge of the Simanjiro plain. Most literature in pastoral land transformations tend to focus on increases in population density and concomitant increases in poverty, or insecure land tenure (Desta and Coppock 2004, Kabubo-Mariara 2005, Hodgson and Schroeder 2002, Igoe and Brockington 1999, Homewood and Rogers 1991). I contend these two forces work in concert across social and ecological scales. In order to investigate these forces in Simanjiro, I first address the issue of poverty in Simanjiro. Are pastoralists becoming poorer in Simanjiro over the time frame of agricultural diversification? Is poverty the main push for herders to adopt cultivation? Secondly, I examine land tenure insecurity and alternative land uses. How have these pressures impacted the decision to cultivate?

Following a brief appraisal of major theoretical approaches to studying the shift from pastoralism to agro-pastoralism and a short review of settlement history in the Simanjiro area of the Maasai Steppe, I examine the roles of impoverishment and land tenure uncertainty in developing the agro-pastoral landscape of Loiborsoit village, at different social (household, village) and spatial (vegetation zone within the village, sub-village organization) scales and social strata. To do this, I will discuss how decisions at several organizational levels, household versus larger groups at the village and subvillage level, have interacted both with each other and with national economic and wildlife policy. The chapter concludes with a discussion of the implications of these dynamics for future conservation policy.

## SHIFTING FROM HERDERS TO HERDER-FARMERS: TWO THEORETICAL FRAMEWORKS

This paper analyses landscape change in two ways. In the first, diversification and economic decisions made by individual households determine the shift from

pastoralism to a mixed herding-farming system. Theoretically, this analysis is underpinned by intensification theory and is based upon changes in the demand for agricultural products. The other method of examining landscape changes falls under the loose rubric of political ecology. This analysis focuses on the altered structure of Tanzanian land use and conflicting resource agendas, and in this context is played out in the collective decisions of villages and subvillages.

*Intensification theory* explains the transition from low input, extensive agricultural activities, such as shifting agriculture or pastoralism, to high input or capital and/or labor intensive agriculture as a reaction to farmers' production goals. The demand for increased subsistence production is normally attributed to increases in population density and the pressure to extract more resources out of a geographically limited resource base (Boserup 1965, Tiffen et al. 1994, Olson et al. 2004, Brookfield 1972 and 2001, Stone 2006). The first to articulate the relationship between population density and agricultural intensification was a World Bank economist, Ester Boserup (1965). Based on observations of shifting cultivators, she theorized that as population increases, farmers decrease the length of the fallow period between farming rotations, leading inexorably to a system of annual plantings entailing increased labor and effort. Intensification is thus the result of individual household welfare decisions across spatial and temporal scales. Population pressure is thought to have led to tremendous increases in agricultural production in many areas of the world (Tiffen et al. 1994, Netting 1993, Stone 1996). While the thesis has been modified and altered (Turner et al. 1977, Datoo 1978, Brookfield 2001), the basic concept of the agricultural progression still informs agricultural policy in the developing world (Wolmer 1997).

The pastoralist literature has focused largely on population as the major driving force (for example, Desta and Coppock 2004, Kabubo-Mariara 2005), yet Boserup's model is only one of several demand themes focusing on subsistence, as opposed to commodity, production. A more appropriate variant is the *modified consumption theme*, in which demand is expanded to include social, biological and market forces (Brush and Turner 1987). Theoretical support for this theme in pastoral research was developed by Mace (1993) by applying optimality modeling developed from behavioral ecology to the transition between herding and agro-pastoralism. Her models expanded the subsistence theme to include the growing cash economy by examining the circumstances which might cause herders to move between herding and agro-pastoralism. She found declines in household wealth led to a shift towards agro-pastoralism[5] and as subsistence requirements increased, a shift to agro-pastoralism became even more likely. [6] In Tanzania, the need for cash to pay for veterinary medicines, hospital costs, and education as well as grain has increased the subsistence requirements considerably. The modified consumption theme is broader than Mace's model however, and includes not only basic survival but also social values intrinsic to the population involved, such as bridewealth, production for ritual needs and the probable shift between consumption and commodity production (Brush and Turner 1987). As the goals of the farmer change (subsistence, risk minimization, prestige), so does the type of agriculture practiced, within the environmental and technological bounds of the socio-ecological system.

[5] The term agro-pastoralism here merely indicates a combination of cultivation and herding practiced by the same family. It is not a mixed farming model as described by Wolmer (1997).

[6] Mace's model does not predict the responses of rich pastoralists as clearly. Wealthy pastoralists are presumably not subsistence/cash limited and therefore apparently cultivate for reasons not included in the model.

*Political ecology* is an interdisciplinary framework for the study of human-environmental relations that combines ecology and political economy to examine the relationship between power inequities and environmental change (Blaikie and Brookfield 1987, also Zimmerer and Bassett 2003, Neumann 2005, Peet and Watts 1996). Unlike intensification theory, which assumes smallholders and other individual land use managers are able to follow the most rational path for survival from the entire range of possible actions, political ecology takes the view that land managers may not be able to take the most sustainable or economic use of land, due to political imbalances, land tenure insecurities, wealth differentials, etc. (Blaikie and Brookfield 1987). Thus, environmental degradation is less a technical problem than a social problem (Neumann 2005). Land tenure has been a consistent feature of political ecology studies since its inception: pastoralism and pastoral land use have also received much attention due to the spatial interface of traditional land use and modern conservation planning (Homewood and Rogers 1991, Turner 2003, Zimmerer 2000). The alienation of pastoral grazing lands has been the focus of much of this research (Hodgson and Schroeder 2002, Igoe and Brockington 1999, Homewood and Rogers 1991). These studies point out that pastoralists are now surviving on less than half of their traditional grazing areas (e.g. Ndagala 1997), and are highly critical of attempts by conservation interests to claim the remaining pastures for wildlife preservation.

Pastoralists are continually managing risk, both real and perceived. The study of changes in pastoral land-use must therefore look at decisions of individual herders living in uncertain environmental and political conditions (Little and Leslie 1999). The pastoral literature views cultivation as just one of many income diversification strategies

pastoralists use to minimize risk. Little et al. (2001) succinctly argue that instead of a general risk aversion strategy, cultivation is undertaken by different groups within a single community at different times and for different reasons. Additionally, the drive to farm can emerge at a variety of organizational scales—household, village or even regional levels. As in Boserup's consumption demand model, generalizations may mask large differences of extreme practical importance to the success of development projects. This dissertation examines the impact of conservation boundaries on changing pastoral livelihoods, but this chapter broadens the subject to include how the Maasai have adopted cultivation as a reaction to external and internal boundaries, fluctuating livestock holdings, environmental uncertainty and political insecurity.

## SITE CHARACTERISTICS AND METHODS

### *The Tarangire-Manyara-Simanjiro ecosystem*

While Maa-speaking people live throughout the Rift Valley region in both Kenya and Tanzania, this paper focuses on the Maasai of Tanzania, in particular the Simanjiro Plains region of northern Tanzania. Simanjiro district lies at the eastern extent of the Tarangire-Manyara Ecosystem (TME), a zone encompassing all the lands surrounding Tarangire and Manyara National Parks that are considered to be one ecological unit, defined largely as the watershed for the Tarangire River. This ecosystem, alternatively called the Tarangire-Manyara or Maasai Steppe Heartland[7], covers approximately 35,000 $km^2$ of semi-arid and arid savanna surrounding the two national parks. Lands beyond the park boundaries are critical for many of the ecological processes within the protected

[7] African Wildlife Foundation originally referred to the region as the Tarangire-Manyara Heartlands as a part of their African Heartland Program for conservation. It has recently been renamed the Maasai Steppe Heartland. http://www.awf.org/heartlands/maasaisteppe/

areas. During colonial rule this area was the center of the Masai Reserve, a demarcation laid down by the British to keep the 'war-like' Maasai from raiding neighboring agricultural people and (more importantly) to open up former Maasai pastures in high potential zones to white settlement (Ndagala 1990, Hodgson 2003). Pastoralists have utilized the region for centuries. The Maasai currently living in the TME, the Kisongo section of Maasai, pushed out another section of Maa-speaking herders several hundred years ago.[8] The Kisongo section is split into a number of subsections: the Tarangire region encompasses the Manyara and the Simanjiro sub-sections.

The rangelands of Simanjiro support plant and animal communities similar to the short and medium grass plains in the Serengeti (Kahurananga 1979). Migrating herbivores, especially wildebeest and zebra, travel between dry season ranges within protected areas and wet season ranges beyond park boundaries. While rainfall determines when the plains can be utilized by grazers, the importance of this region to wildlife can be found in the grass and soil itself: their high levels of phosphorus are critical for lactation and the plains hosts the major calving grounds for Tarangire wildebeest and zebra (Voeten 1999). Non-migrant (resident) herbivores, such as impala, Grant's gazelle and greater kudu live throughout the region all year and are thus important species for the hunting industry. Oryx migrate to the plains after the large migrations of wildebeest and zebra have returned to the park for the dry season, coinciding with the official hunting season. Elephant are very important in Tarangire National Park, but uncommon far from park boundaries. However, elephant raids on

[8] The Parakuyo agro-pastoralists who formerly lived in Simanjiro currently live along the northern coastal savannas east of the district.

crops growing near the plains have increased in the last few years, possibly related to intense drought conditions in 2006.

The village of Loiborsoit-A[9] was originally selected for fieldwork because it was at the edge of the cultivation frontier moving across the district. Additionally, due to the extent of cultivation, its proximity to the Arusha markets for agricultural produce, gemstone deposits and national parks, Loiborsoit residents have many opportunities for economic diversification[10]. Historically, they have been subjected to less interference from the national government than Tanzanian Maasai in the Serengeti-Ngorongoro biosphere reserve, or the Kenyan Maasai territories which have been heavily fragmented by immigration and privatization begun in the 1970's (for Kenyan examples see Campbell 1993, Lamprey and Reid 2004, for Tanzanian examples see Århem 1985, Homewood and Rogers 1999, McCabe et al. 1992 and Hodgson 2001). As cultivation has become more established among its residents, the village has found itself in the midst of conflict between various visions of land use in Simanjiro. Just prior to fieldwork in the area, the village was involved in a series of land-use meetings with the Tanzanian National Parks Authority (TANAPA) that unsettled both the Maasai and the conservation community in northern Tanzania. At the same time, the national government was interested in the region as a possible site for resettling landless poor from the overcrowded agricultural highlands and international agricultural development (Igoe and Brockington 1999).

[9] There are two Loiborsoit villages in Simanjiro District, Loiborsoit-A and Loiborsoit-Moipo. The villages are at opposite sides of the district.

[10] While Loiborsoit does not have deposits of semi-precious gemstones, other villages in the plains and the greater Simanjiro District region contain deposits associated with the Mozambique belt. These include Grossular green garnet (marketed under the name Tsavorite), blue zoizite (marketed under the name Tanzanite), and the red and Malaya garnets. Many Loiborsoit youth are employed in this industry.

Loiborsoit is a rapidly growing village subdivided into 9 mixed-use *vitongoji* (subvillages) and a large pasture reserve. An initial census of bomas[11] and households found 55 more bomas than in 1994 (Lama 1998)—a 40% increase in less than 10 years (Table 2.1). According to informants, bomas consist of fewer households than was traditionally the case, but population has also increased. In 2002, the Tanzanian National Census counted 4154 individuals in Loiborsoit: 15.9 people/km$^2$ living within the mixed-use zone and 5.5 people per km$^2$ across the entire village space. The first number is probably high as the census counted anyone found in the village, including workers on commercial farms outside of the mixed use zone. It is quite a bit higher than the 9.4 persons per km$^2$ found for the mixed use zone in 1994 by Lama (1998), yet lower than found around the Maasai Mara in Kenya, where pastoralism appears to be at or beyond the peak density possible for traditional livestock management (Lamprey and Reid 2004).

***Data Collection***

As the population of Loiborsoit appears to be within the density at which traditional pastoralism methods are plausible, I focused my efforts on the questions of poverty and land tenure. In order to examine the research questions, I used data from a number of sources. First, this paper draws from semi-structured interviews of a sample of 79 bomas, 58% of the total village population. The interviews provided me with an estimate of livestock holdings per capita, a list of the reasons why herder-farmers began to cultivate and the local narrative for the transformation of Loiborsoit's rangelands into a mixed field and pasture landscape. Dissertations, theses and grey literature from development organizations corroborated and extended the collected data to cover the past

[11] A *boma* (Swahili) or *enkang* (Maasai) is a group of households brought together to share herding labor.

**Table 2.1 Population of bomas and households by subvillage, Loiborsoit A: 1994 and 2001-3**

| Variable | Subvillage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Engarkash A | Engarkash B | Lemooti | Loosasia | Madukani | Mbuko | Nyorhit | Olmotoo | Osilale | Total |
| Total *boma* 1994 | 5 | 7 | 4 | 6 | 2 | 14 | 16 | 23 | 4 | 80 |
| Median *boma* residents 1994 | 48.8 | 44.3 | 31.5 | 27.2 | 8 | 20.1 | 19.4 | 28.3 | no data | 27.6 |
| Total *boma* 2001 | 12 | 19 | 5 | 10 | 5 | 21 | 19 | 38 | 6 | 135 |
| *Boma* Sampled 2001-3 | 7 | 11 | 3 | 5 | 5[a] | 12 | 11 | 23 | 2 | 79 |
| Median *boma* residents 2001-3 | 10 | 28 | 26 | 11 | 9 | 21.5 | 24 | 24 | 14 | 20 |
| Total households sampled 2001-3 | 17 | 27 | 5 | 7 | 6 | 19 | 18 | 70 | 3 | 172 |
| Average households per *boma* 2001-3 | 2.4 | 2.5 | 1.7 | 1.4 | 1.2 | 1.6 | 1.6 | 3.0 | 1.5 | 2.2 |
| Median Family Size 2001-3 | 7.5 | 8.0 | 16.0 | 7.0 | 8.0 | 13 | 8.5 | 9.0 | 11.0 | 9.0 |
| Percent of HH heads Maasai, 1994 | 100.0 | 72.0 | 100.0 | 100.0 | 32.4 | 89.4 | 70.5 | 92.3 | 100.0 | 64.5 |
| Percent of HH heads Maasai, 2001-3 | 76.5 | 100.0 | 100.0 | 85.7 | 83.3[b] | 73.7 | 87.0 | 92.2 | 100.0 | 92.2 |

Source of 1994 data: Lama (1998)

[a] At the start of the study period there were 5 bomas in this subvillage, but by the end the disbanding of a sample boma in a different subvillage resulted in 6 total bomas and 5 in the sample.

[b] Percent includes only households living in sampled bomas. There is a large population of non-Maasai households in Madukani not living in bomas, which are included in the 1994 census but not the 2001-3 sample.

century. Bomas were chosen as a random sample, stratified by subvillage to encompass environmental variation. When possible, all household heads of each boma were interviewed intensively. After repeated attempts to contact a traveling household head failed, another member of the household, usually an older son, was interviewed. The household heads included men from six age sets[12] and several women, mostly widows. Interviews were conducted in Kiswahili with a Maasai translator; after living in the village for several months, I was able to understand a great deal of the answers and if necessary could backtrack for greater clarification. The 161 households[13] were grouped into five wealth classes based on Potkanski's wealth criteria (1999).[14] Data from these surveys were analyzed using the Survey package of the open-source statistical program R (Lumley 2006, R Core Development Team 2006).

Poverty among pastoralists is largely determined by the number of livestock per person (Potkanski 1999). A livestock census of nearly[15] all bomas in the village was conducted and age structure was assessed for 123 out of the 135 bomas. This census was expected to serve as a check on self-reported livestock holdings for sample households and to compare against historical data on livestock holdings in Simanjiro. Alan Jacobs (1965) conducted counts of cattle age and gender structures for 14 families in 1957—nine herds of fewer than 100 head of cattle and five with herds greater than 100 cattle. He

[12] Maasai society is divided into age-sets. Young men are circumcised in groups: after circumcision, they become warriors belonging to the same age-set. Together, these men will become senior warriors and, in time, graduate to become elders (Appendix II).

[13] Data were collected for 172 total households but hunter-gatherer families and those with missing individual livestock estimates have been excluded from the household level wealth analysis.

[14] Ethnography by Potkanski shows this to be a reasonable index of wealth in a traditional pastoral system.

[15] Two bomas refused permission to count their herds: discussion with informants determined their self-reported counts to be fairly accurate. Several other bomas had animals in remote areas outside of the village, these we were unable to reach and were left out of total counts in this analysis.

presented data for these families and counts done by the Colonial District Veterinary office for the region during the 1950s. By comparing his data for the 1950s, 20 years before the creation of the national park and before major development projects altered Maasai lifestyles, I am able to check for major shifts in the age and gender of cattle herds from a more traditional pastoral system in Simanjiro and the current herder-farmer system. This is useful because counts of cattle per capita are not available for the earlier time period, nor is a total survey, so it is impossible to compare basic poverty data across the two time frames. The goals of a livestock herder will dictate the age-gender structure of the herd—managing a cattle herd for meat sales should result in a different herd structure than a system managed for milk consumption (Upton 1986). In West Africa, poorer households have been shown to manage their herds differently than wealthier households, simply out of necessity (Sutton 1987, Coppock 1994). Thus, what we do not know about historical poverty levels may become apparent through the age-sex structure of the historical herds when compared to modern herds of the same size. Perhaps more importantly, examining the differences in age-sex structure for large and small herds across time can indicate the ability of these families to withstand drought conditions without being forced to sell productive milking cows.

There are two central dilemmas in comparing Jacobs' data with that of the present study. First, his data were recorded as a set of rounded proportions: while the total number of cattle is available, the exact number of animals in each gender and age group are unavailable. Second, he did not define a *family*. However, during that period, Maasai bomas would have had a separate gate for each household[16], through which each

[16] Bomas frequently, but not always, continue to have this structure in Loiborsoit.

family would bring its livestock into the central corral. Therefore I assume by family he meant a single polygynous household. My census was done at the boma-level: in order to evaluate possible changes in cattle herd structure by family, I limited the comparison to sampled bomas containing only one household. Even limiting the comparison to single household bomas, there are 24 potential household-bomas with small herds (<100 cattle) in the 2002 data set, a total 921 cattle versus 540 head of cattle in the 1957 data set. This discrepancy in the size of overall herds would cause even small differences between the modern and historical structure of cattle herds to be declared statistically significant. To address this issue, a random selection of 9 families (single household bomas) was drawn from the 2002 data set and compared against Jacobs' proportions. If the proportion of bulls, steers, milking cows or calves has been stable over the past 50 years, this random sub-sample should have very similar proportions. The random sample was compared with Jacobs' 1957 proportions using the Pearson chi-square statistic, although any measure of deviation would work. The process was repeated 1000 times, each time producing Pearson's statistics using a new random sample of families. Over 90% of the Pearson chi-square statistics exceeded the .95 quantile of a chi-square distribution (df=3), many more than the 5% expected by chance if the 1957 proportions held true. A similar process was followed for the six single household bomas with more than 100 head of cattle in the sample, although only 6 different sub-samples of 5 households were possible. The residuals were examined for both small and large herds to determine which livestock categories were least similar to the 1957 data.

## SETTLEMENT AND FARMING DURING THE EARLY YEARS OF INDEPENDENCE

*"We began to farm when the government brought us to Loiborsoit and told us to farm*."
--Senior elder, *Irkishumu*, a warrior during Operation Imparnati.

Pastoralism is an extensive form of agriculture; requiring large amounts of land to support a relatively low population density (see Chapter 4). The ability of East African pastoralists to access their traditional territories was initially restricted by the colonial governments. Tanganyika, the Tanzanian mainland, was a German colony from the mid-1880s until 1919, when Germany officially lost control of Tanganyika in the Treaty of Versailles (Hodgson 2001). Britain then held Tanganyika as a protectorate until Tanzanian independence in 1961. For 75 years, these Western powers defined the Maasai as a people dependent solely on milk production and consumption for subsistence, ignoring a long history of grain consumption (Hodgson 2001). Based on this assumption, the Maasai were restricted to areas too marginal for cultivated agriculture and European settlement or considered critical for wildlife conservation. Migration across the boundaries of these "native reserves" was forbidden to both Maasai and cultivators. Ironically, the loss of so much territory made pure pastoralism untenable, as idealized by the colonial authorities. The compression of pastoralists into smaller territories also led to concerns that herders were overgrazing the range. Agroecological realities made cultivation a risky production system in arid areas and essentially mandated low population densities in many pastoral regions. Despite this, the colonial governments, particularly the British, tried to convince pastoralists to make the switch to settled agriculture, often attempting to destock herds in order to decrease the perceived overgrazing problem (Fratkin and Mearns 2003, Behnke and Scoones 1993, Hodgson and Schroeder 2002). These misguided development projects failed to realize that the

colonial history which helped create the ideal of the Maasai as pure pastoralists also made the ideal impossible.

Historically, Maasai have never been as conservative and monolithically pastoral as they are perceived as being (Hoben 1977, Århem 1985, Hodgson 2001). For example, in 1968 Kenya Maasai took up wheat farming to such an extent as to overwhelm the capabilities of the colonial government to utilize the grain (Jacobs 1975, cited by Hoben 1977:23). It is also widely recognized that historically Maasai maintained relationships with both cultivators and hunter-gatherers in order to maximize survival in the face of an inherently risky environment (Galaty 1993, Spear 1993b, Waller 1988). There is even evidence that beyond personal relationships with cultivators, the Maasai themselves have always been involved in cultivation (Hodgson 2001). However, the transformation in Simanjiro over the last 20-30 years is seen as decisively different from this past, largely due to the *extent* cultivation has altered traditional pastoral lives and landscapes.

Loiborsoit is the oldest settlement on the Plains, yet for the first 40 years of its existence was only a colonial outpost in the wet season pastures of transhumant pastoralists (Kahurananga 1976). During these early years, cultivation was limited and nearly as ephemeral as its mobile Maasai population. Small maize gardens were tended by women inside abandoned cattle kraals, benefiting from both the deep manure left by penned livestock and old fencing made of thorny bushes which protected the crops from wildlife. By 1971 more consistent, but still limited, cultivation had been established, but permanent settlement was still nearly nonexistent.

The development of Loiborsoit village into a Maasai settlement began during the national villagization program in the 1970s. Villagization (Operation *Vijiji* or

*Imparnati*[17] in Maasailand), a resettlement scheme set in motion by the post-colonial *Ujamaa* socialist regime[18], expanded the loss of land and the drive to change pastoral land use, attempting to bring recalcitrant herders in line with national productivity objectives. The post-Independence national government was dedicated to a policy of socialism and self-reliance, formally laid out in the 1967 Arusha Declaration. In order to reach these goals, Tanzanians were first encouraged and then forced to move into *ujamaa* villages, in which people were to live and cultivate together on land held communally. While the program was an economic failure, it irrevocably altered the cultural and ecological nature of the Tanzanian landscape (Kikula 1997). Ndagala (1982, 1990) and Århem (1985) both note that villagization was more flexible in Maasailand than other areas and relocations were relatively minor, using existing settlements for the plan's layout. Operation *Imparnati* was seen by some Maasai as a means to secure land rights and protect their resources from agricultural encroachment (Århem 1985). Ndagala (1990) points out that the failure of the government to fully demarcate and title village lands during this period set the stage for future land grabbing and allocations by higher levels of government without local input.

Operation *Imparnati* used the small market in Loiborsoit as a settlement node in 1977; during this time a Swedish Pentecostal Mission was also established. The Mission has had a tremendous impact on the village by building and maintaining water and education infrastructure. It has also attempted to modernize the Maasai by promoting cultivation: European support of the small farms created during Operation *Imparnati*

[17] *Imparnati* roughly translates as 'to become sedentary' in the Maasai language (Århem 1985).

[18] "Ujamaa" translates roughly to "Familyhood." It is the Swahili description for a form of African socialism.

became the nucleus of the current agro-pastoral landscape in Loiborsoit. Ironically, the official goal of Operation *Imparnati* was to adapt the villagization model to pastoral economies through intensifying livestock production, not cultivation (Århem 1985, Ndagala 1982)

**LAND SUBDIVISION AS A FARMER-DRIVEN PROCESS**

*In dry years both livestock and fields suffer. But with good rains, fields will produce well the next year, while livestock can take years to recover*—Junior elder (*Landis* age set)

*I was tired of selling cattle to buy food. Farming supports my livestock*. –Senior elder (*Irkishumu* age set)

*We are tired of being poor.*—Junior elder (*Landis* age set)

As the quotes above suggest, poverty, risk avoidance and livestock protection all factor into the individual decision of whether or not to farm. In Loiborsoit the process has led to near universal adoption of at least some cultivation. All but 5 out of 172 household heads interviewed planted at least one field in 2003.[19] This section addresses the economic reasons for shifting from 'pure' pastoralism to a herder-farmer[20] system using demographic data gathered during interviews, historic measures of wealth and the reasons household heads themselves give to explain the shift. First, I examine several characteristics of stressed pastoral economies and then the integration of cultivation into the subsistence strategy of the Loiborsoit Maasai. Finally, this section will address the question of whether the integration of cultivation heralds the end of pastoral culture.

[19] Three of these non-cultivating households were Dorobo, hunter-gatherers who have moved into Maasai bomas for protection and neither herd nor plant.

[20] I use the term herder-farmer, as used by Miamir-Fuller, as opposed to agro-pastoralist because most of the interviewed household heads viewed themselves as pastoralists who farm on the side. I define agro-pastoralism, on the other hand, as a farming system where livestock and cultivation are integrated and ecologically compliment each other. The WaArusha households most closely follow this designation.

***The status of Loiborsoit's pastoral economy***

The status of the traditional pastoral economy can be measured by the ratio of livestock per capita, the proportion of small to large livestock kept and the age and sex structure of livestock herds. The pastoral system depends upon maintaining a high ratio of livestock per capita, a measure that is falling throughout pastoralist regions in Africa (McCabe 2003, Desta and Coppock 2004, Little et al. 2001, Turner 1999). In his discussion of wealth and traditional support among the Ngorongoro Maasai, Potkanski uses the cutoff of 5 livestock units (LU[21]) per person to be the minimum amount of livestock necessary for a family to survive as "pure" pastoralists. Just over twenty percent of Loiborsoit's Maasai households meet this threshold (Table 2.2). The rest of the population, nearly 80% of the sampled Maasai households and over 80% of all households, cannot meet their family's needs as pastoralists, far more than indicated by Potkanski for nearby villages in Simanjiro just 10 years earlier (1999). The minimum base herd size for a new sub-household (newly married wife within a polygynous *boma*) is 8 cows and 1 steer: more established households would require more than 8 cows (Muir 1994). While data were not collected specifically at the sub-household level, by dividing the number of wives by the number of cows in the sampled bomas it can be estimated nearly 78% of the sub-households have fewer than 8 cows[22]. Fifty years ago,

[21] A livestock unit is an index of herd species and their impact on subsistence used widely in pastoral literature. 1 LU is equal to 1 head of cattle or 10 head of smallstock (sheep or goat) (Potkanski 1999, McCabe 2003). Potkanski developed this equation based on in-depth ethnography with the Maasai of Ngorongoro and relates to the amount of possible food produced by one animal.

[22] This assumes an equal livestock distribution among wives. This is, of course, unlikely. Nonetheless, this is the calculation used by Muir (1994) in assessing the state of pastoralism for livestock development. An uneven distribution of livestock among wives would probably increase the number of sub-households with fewer than 8 cows.

**Table 2.2 Distribution of sampled households and bomas in Loiborsoit A across wealth classes (%), 2001-3**

| Households, by wealth class[a] (%, n=161) | All households (n=161) | Maasai headed (n=142) |
|---|---|---|
| Wealthy (>5 LU[b]/capita) | 21.52 | 22.54 |
| Middle-class (2.5-5 LU/capita) | 20.89 | 21.80 |
| Poor (1.25-2.5 LU/capita) | 18.99 | 19.01 |
| Very poor (0.5-1.25 LU/capita) | 18.99 | 17.61 |
| Destitute (<0.50 LU/capita) | 21.52 | 19.01 |

| *Bomas*, by wealth class (%, n=79) | All *bomas* (n=77) | Maasai headed (n=65) |
|---|---|---|
| Wealthy (>5 LU/capita) | 11.70 | 12.50 |
| Middle-class (2.5-5 LU/capita) | 40.26 | 45.31 |
| Poor (1.25-2.5 LU/capita) | 23.38 | 18.75 |
| Very poor (0.5-1.25 LU/capita) | 18.18 | 18.75 |
| Destitute (<0.50 LU/capita) | 6.50 | 4.69 |

[a] Wealth classes are based on Potkanski (1999) for Ngorongoro Maasai in northern Tanzania.
[b] LU = Livestock Unit. 1 LU = 1 head of cattle or 10 smallstock (Potkanski 1999).

Jacobs (1957) estimated the Simanjiro Maasai consumed nearly 80% of their yearly diet in milk. While milk is still the most prized food, during the 2001-3 time period very few herders were able to maintain such a high consumption of milk, even during the peak production times. In fact, hunger, due to livestock loss or decrease in milk production was the main reason reported for farming by all but the wealthiest households and accounted for 33% of all responses (n=167) (Table 2.3). This suggests other income diversification strategies, such sending sons to work as gemstone brokers or in the wildlife tourism industry, have not made up for shortfalls in milk production.

Another sign of an economy under stress is the changing structure of pastoral herds, both between and within livestock species. The average LU per person increased

**Table 2.3: Reasons for cultivating by wealth class (%), (n=165)**

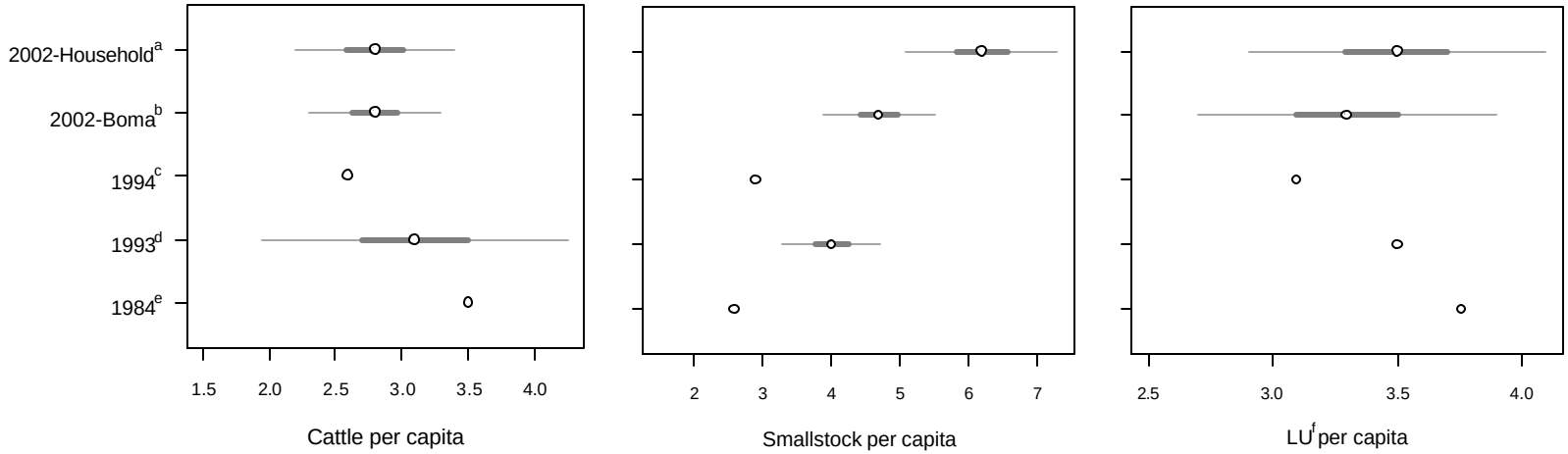
| | Destitute | Very Poor | Poor | Medium rich | Wealthy | Total |
|---|---|---|---|---|---|---|
| | *%* | *%* | *%* | *%* | *%* | *%* |
| Fewer Livestock / Less Milk / Hunger | 42.31 | 35.00 | 40.00 | 34.29 | 17.65 | 33.33 |
| Wanted to eat Maize | 0.00 | 7.50 | 3.33 | 2.86 | 0.00 | 3.03 |
| Tired of Buying Maize | 0.00 | 5.00 | 3.33 | 8.57 | 2.94 | 4.24 |
| Protect Herd | 7.6 | 5.00 | 0.00 | 14.29 | 17.65 | 9.09 |
| To Make Money | 3.8 | 10.00 | 6.67 | 5.71 | 20.59 | 9.70 |
| Influenced by Family | 11.54 | 7.50 | 26.67 | 20.00 | 29.41 | 18.79 |
| Influenced by Agriculturalists / Friends | 19.23 | 15.00 | 10.00 | 8.57 | 2.94 | 10.91 |
| Ethnicity | 11.54 | 7.50 | 10.00 | 2.86 | 5.88 | 7.27 |
| Government directive | 3.85 | 5.00 | 0.00 | 0.00 | 2.94 | 2.42 |
| Other | 0.00 | 2.50 | 0.00 | 2.86 | 0.00 | 1.21 |
| *Totals* | *100.00* | *100.00* | *100.00* | *100.00* | *100.00* | *100.00* |

Notes: Responses are divided into 4 groupings for easy reading: reasons revolving around food needs or wants, reasons more clearly oriented towards not selling livestock, pressures from family or friends, and other pushes towards farming. These categories are not mutually exclusive.

slightly between 1993-4 and 2002 (Figure 2.1) but appears to have decreased overall since 1984. Herd sizes were self-reported at the household level: a total census of village livestock numbers at the boma level conducted during the first weeks of the 2002 short-rains (October) found similar LU measures using both counts. However, the similarities mask an apparently large shift from cattle to smallstock in the studied populations. Self-reported cattle holdings were lower than the actual count of animals present during the boma census, but smallstock holdings were larger when self-reported. Yet in both cases, the average number of cattle per person was 10.4-18.2% lower than found during a district livestock census in 1984 (the actual decrease is probably closer to 10.4% due to the migration of few large herds during the census to avoid conflicts with herd owners' fields). Conversely, smallstock holdings per capita have soared, with a minimum increase of nearly 20% since 1993 and almost 150% more smallstock per person than 1984.

The longer record supports these data. Jacobs's survey of Simanjiro cattle herds in the 1950s, prior to the widespread alienation of pastoral lands, apparently found smallstock holdings too insignificant to report, yet by 1994 smallstock comprised an integral portion of the pastoral herd in Loiborsoit (Jacobs 1965, Lama 1998). In 2002, the smallstock population had increased again, nearly doubling from 1994. Over the short term this may reflect recovery from droughts in both 1994 and 2000, but over the long term it points to increased cash requirements for food and necessities as smallstock are more easily convertible to cash than cattle. There are several reasons smallstock, particularly goats, are more easily converted to cash than cattle. First, a bull or cow is expensive and local demand for full grown animals is limited. Therefore to sell one it

**Figure 2.1 Mean per capita livestock holdings in Simanjiro District from 1984 to 2002**




Notes: This probability smear graph shows the mean per capita livestock holdings in Loiborsoit (2002, 1994) compared with similar district-wide data available for 1993 and 1984. The center dot is the actual mean, the darker gray line the 50% confidence limit and the thin, light gray line the 95% confidence limit (graph style based on Gelman and Hill 2006). To read the smear graph, focus on the overlap between probability smears. If there is no overlap, the difference between values is significant, for example, the total census for 1994 smallstock is clearly different from 2002 counts, both reported and enumerated. However, the 2002 smallstock per capita are not different from pre-drought 1993 levels. The 1993 and 1994 livestock counts were made before and after a major drought event, confounding comparisons between those years.

[a] Household herd size of sampled households in Loiborsoit, self-reported
[b] Boma herd size of sampled bomas in Loiborsoit, counted
[c] Total census of Loiborsoit village livestock, self-reported. Source: Lama 1998
[d] 1993 samples were non-random and skewed towards wealthy households across the district; LU was calculated by author, no variance available. Source: Muir 1994
[e] Source: Muir 1994. Livestock counts are from a 1988 district livestock census. Human population was estimated using 1988 census figures and deducting the annual growth rate of 2.8% each year to 1984.
[f] LU = Livestock unit. 1 LU = 1 head of cattle or 10 smallstock

must be walked to a far market near Arusha town, particularly to get the best price. Once a bull is sold, the seller then has a large sum of cash on his hands with no banking system and many relatives interested in gaining a share of the proceeds. It is difficult to save cash in Maasailand. On the other hand, goats are the most common meat animal—not only are they inexpensive to purchase, local demand is much higher so the walk to find a market is less onerous. Once the proceeds from the goat are obtained, they can be easily targeted to immediate needs. Sheep are seldom sold because they are important sources of fat for women nursing babies and sick family members. Smallstock also reproduce much more quickly than cattle and therefore are replaced in a shorter time frame. Finally, Maasai are also reluctant to sell cattle because their identity as Maasai requires them to have cattle. If they are very poor, they are unlikely to relinquish their remaining cattle stock if there are goats available for sale.

Interviews with village residents support this conclusion. Smallstock reproduce more quickly and are easier to sell than cattle, so herd owners interested in raising livestock as an income generating pursuit put their efforts into goats and sheep. Another possible indication of changed pastoral goals is the slight increase in the proportion of steers kept in the herds (Table 2.4). Using the Pearson chi-square test, I compared the proportion of age and gender groupings in the 1957 cattle herds with those of 2002 and then plotted the residuals to understand which age or gender categories were farthest from the 1957 baseline. While the structure of large cattle herds was not significantly different from the historical accounts, smaller herds were strikingly different (Figure 2.2). The proportion of bulls has remained nearly constant over the past 50 years, yet smaller herds, which formerly held slightly fewer steers, now contain about as many steers as the

**Table 2.4 Age and gender structure of Simanjiro cattle herds prior to the subdivision of pasture lands (1957) and after subdivision was well established (2002)**

| Herd | Year | Bulls | Steers | Cows | Calves | Total Cattle |
|---|---|---|---|---|---|---|
| ***Families[a] with herds <100 cattle (n=9)*** | ***1957*** | ***7%*** | ***9%*** | ***59%*** | ***25%*** | ***540*** |
| Single household bomas with herds <100 cattle (n=24[b]) | 2002 | 8% | 11% | 49% | 32% | 921 |
| ***Families with herds >100 cattle (n=5)*** | ***1957*** | ***7%*** | ***12%*** | ***61%*** | ***20%*** | ***891*** |
| Single household bomas with herds >100 cattle (n=6) | 2002 | 6%[c] | 10% | 64% | 21% | 939 |
| ***Colonial District Veterinary records of counted cattle*** | ***1950's*** | ***7%*** | ***10%*** | ***58%*** | ***25%*** | ***1,548,722[d]*** |
| Loiborsoit Bomas (n=123) | 2002 | 7% | 11% | 54% | 28% | 6031 |

Notes: All 1950s livestock counts are from Jacobs (1965). Jacobs did not report per capita holdings or smallstock numbers, making it impossible to compare overall livestock holdings before and after land alienation.

a Jacobs did not define 'family'. In order to make the comparison as consistent as possible, I assume 'family' is analogous to a single polygynous household.

b The 24 bomas were re-sampled at n=9 1000 times; each sub-sample was evaluated against the 1957 herd structure using Pearson's chi-square test. All age and gender subsets were found to be significantly different from the historical proportion at the 0.05 level.

c Percentages do not add to 100 due to rounding error. Age and gender structures are not significantly different from 1967 proportions (p=0.627).

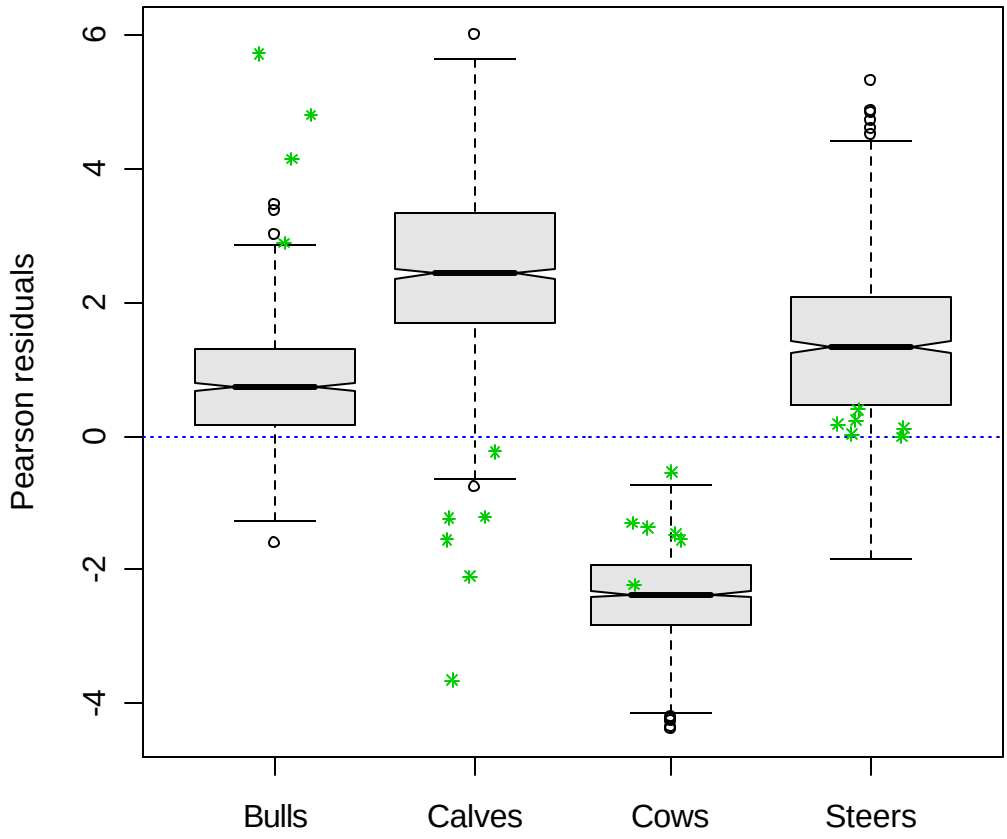
d This number is the total number of cattle counted by British colonial authorities in the entire region, not just Loiborsoit

sell in case of emergencies, or a desire to keep oxen for plowing. Muir (1994) reported wealthy herders had more bulls and steers than poorer herders. The reversal in Loiborsoit might reflect the increase in cash requirements in pastoral lives, but also the possibility of alternative forms of income more readily available to wealthier herders (e.g. larger smallstock herds, educated children working in town).

Despite the differences in smallstock and steer holdings, the age structure of village cattle herd has remains remarkably similar to Simanjiro herd of the 1950s, especially given the intense socio-political changes during this time frame (Figure 2.2). The small sample size precludes meaningful statistical analysis on this data, but I believe the shift in milch cow and calf proportions may be an indication of herds in recovery from the drought in 2000, which residents claim killed many cattle. This shift is particularly evident in the smaller herds, where none of the sampled households had as many cows as the 1957 sample and almost all of the households had more calves (Figure 2.2). It also may be a signal of stress on the system: Sutton (1987) found poorer Fulani households were forced to sell productive cows in order to meet subsistence shortfalls.

The increase in smallstock despite continued maintenance of a pastoral age and sex structure in cattle herds hints at a contradiction borne out in interviews: the cultural desire for a lifestyle based on livestock persists despite greater income needs,. Economic diversification and herd protection made up the second most frequently mentioned group of reasons for adopting (and continuing) to cultivate. In my sample, 13.7% of respondents said they farmed in order to avoid selling cattle to purchase food; 75% of those were in the wealthy and medium-wealthy groups (Table 2.3). Additionally, the monetary demands of modern life are extensive, even in a place seemingly as remote as

**Figure 2.2 Comparison of age and gender sub-components of small (<100 head, box plot) and large (>100 head, *) cattle herds in 2002 as compared with age and gender structure in 1957.**




Notes: Box plot was created in R from 1000 Pearson chi-square analyses of random sub-samples of 9 cattle herd structures from the 24 single family bomas with small herds in the overall 2002 data set. Ninety percent of the random samples were significantly different from the 1957 (Jacobs) age and gender structure.

Superimposed on the box plot is the distribution of Pearson chi-square residuals for a similar test performed on the 6 herds of more than 100 cattle owned by single household *bomas.* These residuals are shown as green asterisks (*). Because of the smaller sample size, only 6 separate sub-samples of 5 herds were possible. The two groups, small and large herds, show a strikingly different pattern, even though only the smaller herds were statistically significantly different from the 1957 baseline proportions.

Simanjiro. Cash is needed not only to buy grain; hospital bills, clothing and most importantly, veterinary drugs, all require access to cash. In this way farming actually supports the pastoral economy. In the wealthiest category of herders, 20.6% began to farm in order to sell crops for cash, some to gain livestock and others to purchase modern

goods. The earliest Maasai farms in the village were begun by this group of people. In the late 1980's, several of these men actually hired themselves out to work on farms owned by expatriates in order to learn how to farm more effectively. Younger wealthy herders were more likely to have been taught by family members, but also report that by farming for food, a greater proportion of money earned through gemstone sales is available to increase and maintain their herds.

### *Acceptability of cultivation*

Younger Maasai men consistently viewed cultivation as just one of many paths towards maintaining their households and quality of life. Tractors are popular purchases throughout the district for young men doing well in the gemstone industry. Members of the Landis age set, who were just becoming junior elders and starting families during the period of field research, were almost as likely to report that they began to cultivate because their father's boma was already farming as because of hunger. They were three times as likely to be influenced by family members to farm as the Irkishumu, the senior elders. Informal inheritance rules for land (as opposed to livestock) have not solidified yet, and with more young men wanting to include farming in their livelihood strategy, the pressure on the village committee responsible for land allocation is intense. At any given time there is a long list of young men requesting land allocations, including both locals and Maa-speakers from outside Simanjiro who have been pushed out of their home areas.[23]

[23] The right to give out land leases is granted to a village land committee (See Chapter 3). In Loiborsoit, preference is usually given first to local Maasai, then to Maasai from outside the village with social ties to village residents. Many of these Maasai are attempting to relocate to Loiborsoit from villages closer to Arusha whose traditional grazing areas have already been lost to cultivators spreading out from Arusha

Women are also frequently behind the drive to allocate and obtain land. The feeding and care of children is primarily the responsibility of women. As milk production and livestock per capita decrease, keeping a regular food supply has become more difficult and women feel this burden most strongly. Despite the increase in labor requirements which particularly impact women (O'Malley 2000, von Mitzlaff 1997), mothers and wives often push their sons and husbands to request allocations and actively do much of the agricultural labor. As families are fragmented by HIV-related deaths and migration of young men in search of wage labor, this situation is unlikely to improve. Additionally, many women told me that even if they had enough cattle to live on milk products alone, they would still farm because they liked maize meal. Even beyond the women, 3% of respondents listed 'like to eat maize' as contributing to their desire to include cultivation in their subsistence pathway (Table 2.3).[24] One mother told me her sons even had to be persuaded to drink ritual cattle blood during the circumcision ritual because they did not like the taste of this extremely important and traditional food. This indicates an extreme shift in the food preferences of some young Maasai.

### *The death of pastoralism?*

It would be a mistake to infer that integration of cultivation into the Loiborsoit cattle economy foretells the demise of pastoralism. This is clear from the consistent structure of cattle herds over nearly 50 years of socio-political changes. The first fields in Loiborsoit were planted by wealthy pastoralists who produced plenty of milk and had

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town. There are also many non-pastoralist people on the waiting list but these are rarely given farming allocations.

[24] It is worth noting that none of the richest herders claimed they farmed for this reason. Whether this is because they do not wish to admit a taste for maize meal or because they have enough animals to sell to obtain maize without planting are open questions.

enough cattle to sell for grain if they so desired. Culturally, pastoralism is still the dominant worldview in Loiborsoit: traditional rituals requiring cattle (circumcision, bride price) are scrupulously kept even by Christianized Maasai, although the willingness and ability to donate cattle, rather than smallstock, to restock poorer clan members has declined. Yet despite intense interest and investment in livestock production, involvement in outside labor opportunities (in particular gemstones and tourism), and the possible increase in cattle holdings per person over the past 10 years (Figure 2.1), cultivation remains a central part of many herders' food production strategy. While some invest heavily in cultivation and reap little, for many even a small harvest is cost effective (see Chapter 4), allowing them to resist selling animals to purchase food and medicines. Additionally, farming the land serves an additional purpose—claiming the land.

### LAND SUBDIVISION AS COLLECTIVE CHOICE: THE SECOND OPERATION IMPARNATI AND BEYOND

*"The safari people and the National Parks are claiming half our village land for the park. We think none of it should be taken"* –former Loiborsoit village secretary *(Irkishumu* age set), quoted by the New York Times (Perlez 1989).

*"We felt that in the future, many people, both Maasai and outsiders, would be looking for land, therefore it was better to split it up amongst ourselves"*—former member of the first Loiborsoit village government *(Irkishumu* age set).

The second hypothesis for why Maasai have taken up cultivation in Simanjiro is land tenure insecurity. This impacts land use from a different level of organization: unlike economic diversification, which is a decision based on household needs and decisions within family groups, the decision to subdivide the land is a collective decision, made at the sub-village and village level. Ndagala (1997) reports several Simanjiro villages preemptively allocating land to stop corrupt government officials from selling

common pool resources to outsiders. I examine pre-emptive land allocation in Loiborsoit more closely, as it has occurred multiple times in response to perceived attacks at varying levels of collective decision-making. First, I will briefly summarize the outside pressures that have led to this sort of land allocation in the village. Then I will discuss the three stages of pre-emptive land allocation in the village: 1) the creation of Loiborsoit as its own entity in 1989, 2) the spread of cultivation to limit allocation by national interests and 3) claiming land in areas of conservation interest.

The failure of the communal "*ujamaa*" villages to increase agricultural production in the 1970s and a crippling war with Uganda forced Tanzania to modify its goal of self sufficiency by the end of that decade (Igoe 2004, Hodgson 2001). Tanzania became increasingly dependent on external funding. Strapped for cash, the government began to hand state-run farms over to individuals and companies, both Tanzanian and expatriate (Igoe and Brockington 1999). For example, nearly a million acres of grazing land in the Simanjiro region was sold to a foreigner named Phillip Steyn (Shivji 1999). By the end of the decade, the sale of land by upper-level government officials in the national capital, Dar es Salaam, had become common, aided by the failure of the national government to fully demarcate and title village lands during villagization (Ndagala 1990, Igoe and Brockington 1999). After a long colonial history of land enclosure for conservation and settler agriculture in the mountain highlands, land had become scarce in the remaining high potential agriculture zones and both the government and farmers (small and large scale together) began to look to nearby semi-arid districts for available land (Neumann 1992, Igoe and Brockington 1999). In response to public outcry against land grabbing, a Land Commission was established in 1991; its 1992-3 report testified Arumeru District

authorities had been told to settle roughly 18,000 landless peasants in other districts (Igoe and Brockington 1999). The traditionally pastoral districts were particularly singled out as having plenty of open space for such resettlement: although this effort ultimately failed, informal immigration was (and is) common.

While economic forces were encouraging land speculation and immigration by small scale agriculturalists, wildlife preservation groups were also beginning to look closely at the Simanjiro plains. The increase in immigration and commercial agriculture had closed most of the routes used by migrating wildebeest and zebra leaving Lake Manyara and Tarangire National Parks during the rainy season, only a few remained open for migration to the Simanjiro Plains (Borner 1985). By the end of the decade, concerns over habitat loss convinced conservation groups to call for the creation of a Simanjiro Conservation Area (SCA), modeled after the Ngorongoro Conservation Area (Igoe 2004). The Ngorongoro Conservation Area (NCA) was created in 1959 to placate the Maasai evicted from the Serengeti National Park area and has the specific mandate to protect wildlife and natural resources while simultaneously furthering the interests of the Maasai population living within the NCA (Homewood and Rogers 1991, Århem 1985, McCabe 2003). In many ways the NCA and its governing body, the NCA Authority (NCAA) was an early experiment in mixed conservation-development projects. Unfortunately, while the outcome for wildlife has generally been positive (Perkin 1995), the outcome for the Maasai has been a disaster. Not only are their herding patterns restricted, Maasai of living in NCAA were seriously malnourished during a period when cultivation was banned within the NCA (McCabe et al. 1992). Even though health indicators improved after cultivation was reinstated, permission to cultivate was later removed and the ability

of herders to take up small scale cultivation has been repeatedly taken away over the years since NCAA establishment (McCabe 2003). After giving up the good grazing lands of the Serengeti, most Maasai are understandably bitter about their status as second citizens to wildlife and tourists in the NCAA. The intricate marriage links between Maasai clans means that nearly all residents of Simanjiro have kin either in the NCAA or who were not allowed to stay in the Serengeti/NCAA when they became protected areas. While it is unlikely the SCA would have been created at that time, its discussion was unsettling to residents who still remembered the loss of the Serengeti and Ngorongoro areas to their kin 20 years before.

***Secession and land allocation***

By the 1980s, Loiborsoit was administratively only a sub-village of Emboreet, yet the complex socio-political environment created through trade liberalization, increasing population in agricultural areas and the loss of traditional grazing areas to wildlife soon led to its secession from the larger village and to a second 'Operation *Imparnati*'. The Emboreet village chairman was involved in allocating large parcels of land to wealthy farmers from outside the district. Sub-village leaders, members of the *Irkishumu* age-set entering junior elderhood during this time, were increasingly concerned that all of Loiborsoit sub-village would be allocated away from underneath them. The final straw came when a non-Maasai businessman attempted to claim the entire woodland habitat in Loiborsoit as his own farm, even as the case against Steyn's land purchase was continuing its trek through the national court system. In 1987 the sub-village government had a meeting to work out a plan of action; they decided to take the village chairman to court in Dar es Salaam over the dispute. One consequence of this

was that, in May of 1989, Loiborsoit became an officially recognized village and began calling former residents to return home and help lay claim to the land.

Despite the settlement goal of Operation *Imparnati*, Maasai were still following the rains, looking for greener pastures for their animals. By sending out word through Maasai travelers, men who had lived at one time in the village, or who had been a part of the large bomas there in the 1970s, were asked to return and help protect their home area. They were allocated large plots of land, both in the woods and in the plains of the village. During this second "Operation Imparnati," men were able to choose where they wanted to live; in later years land was spatially allocated in relation to family members who already held land. There is some ambiguity about the size of these original allocations[25], but generally they were more than 200 acres and some members gained more than one allocation.

***Plowing land to claim ownership***

The allocation of land in the village has continued even after village establishment, both from a desire to cultivate, as discussed in the first section, and because secession did not remove the sense that local hold on land was fragile and subject to change. Recent rearrangements in national governance have exacerbated this fear. In 2002, Arusha Region[26] was carved into two, creating a new Region called

[25] Technically, by Tanzanian law allocations greater than 10 acres must be approved by the District government, allocations greater than 100 acres must be approved by the Region and over 1000 by the National government. However, Perlez (1989) reports village officials using 30 acres as the **minimum** allocation size. In fact, all of my informants who gained land during this early period claim at least 50 acres and frequently well over 100. It must also be said that allocations have not been surveyed and boundaries are constantly negotiated. Most people don not know the size of their allocations accurately.

[26] Regions are the largest administrative unit in Tanzania. Regions are broken into Districts and then into Divisions

Manyara. The former Arusha Region was extremely large and difficult to govern, wealthy due to the presence of the major National Parks and the gemstone mines near Mererani village, and contained most of the pastoralists in the country. The new region encompasses Tarangire National Park and Simanjiro and has the headquarters based in Babati.[27] Given the contorted outline of the new region, many Simanjiro residents were convinced their relocation into Manyara region was due to the political clout and land hunger of Mbulu cultivators, whose overcrowded home district housed the new regional headquarters.

Coming on the heels of the creation of Manyara region, a letter was sent by the National Investment Centre (NIC) to the district offices in Simanjiro and then sent to all villages in the district. The NIC is an agency of the Tanzanian government responsible for promoting and coordinating local and international investment. This letter, a form letter sent to both urban and rural areas, asked local governments to compile lists of unallocated land or land otherwise open for development. While actually asking for land open for commercial farming it arrived soon after the subdivision of Arusha region and appeared to confirm the fears of many Simanjiro residents throughout the district. Rumors of the letter were a major topic of speculation and concern in the village during the middle of 2002. The village leaders I spoke with were aware the request referred to land open for commercial farming purposes, not national support for Mbulu expansion. Still, the village council was concerned enough to suggest residents with unfarmed land allocations should consider plowing at least a few acres to prove ownership or the land

[27] In order to reach the regional headquarters, residents of Simanjiro must either travel to Arusha town and then take a bus to Babati, or walk through Tarangire National Park.

would be reallocated to villagers on the waiting list in order to prove to any national officials that the land was in use.

### *Claiming areas of conservation concern*

Loiborsoit covers the northwest portion of the calving area for the Tarangire population of wildebeest and zebra. In addition, it shares part of the 'corridor,'[28] or wildlife migration zone with a neighboring village. This zone includes a bottleneck created where a large seasonal swamp narrows to a point traversable by wildebeest traveling in between the park and the plains. Both mating and calving season occur on the plains during the rains (Kahurananga 1976). The plains are a critical component of the wildebeest lifecycle: its grasses have higher levels of phosphorous than those inside the park, a mineral important during the calving season for lactating wildebeest (Voeten 1999).

The village government has allocated all the land in this area and it has been farmed intermittently for the past decade. Most of the land adjacent to the village pasture zone was allocated when Loiborsoit seceded, yet it had not been farmed until recently (see Chapter 4 for descriptions of land use zones in Loiborsoit). Some land between the corridor and the village market area was allocated in small 10-acre blocks during the mid-1990s to widows and non-Maasai immigrants, but these allocations were later rescinded with a shift in village politics. Local politics have been defined for a decade as the struggle between local administrations interested in maintaining open pasture for their

[28] The term wildlife corridor in East Africa generally refers to the paths that the animals themselves take, not to linear strips of habitat maintained by humans for species' survival as are found in the West. It is a loaded term in the context of Africa. See Goldman 2006 and Lynn (forthcoming) for different takes on the utility of the corridor concept in East Africa.

herds and administrations willing to farm the entire area to protect it from outside interests. In general, cattle-wealthy bomas dominate the corridor area and prosperous herd owners could be an ally of wildlife interests, yet as discussed before, even the wealthy bomas are cultivating. The struggle is for the *extent* of the farming in valuable pasture lands.

The village has used the wildlife sector itself to protect their land by asking safari companies interested in using village lands to create infrastructure within the village that would extend village claims to land. For example, they suggested a client photosafari company could build a secondary school for Maasai girls to be located near a borehole lying within the corridor. In 2002, the company drilled a borehole on the high plains as partial payment for the use of village lands. If finished, the borehole would allow the permanent settlement of a distant portion of village land currently only useable during the rainy season[29]. Through these development projects, the village is attempting to use the eagerness of the wildlife sector to gain a foothold in Simanjiro in order to expand village claims to territory—claims which are normally undermined by the conservation industry in Tanzania and which decrease the area actually available to wildlife in the critical habitat zones.

## INTEGRATION AND DISCUSSION

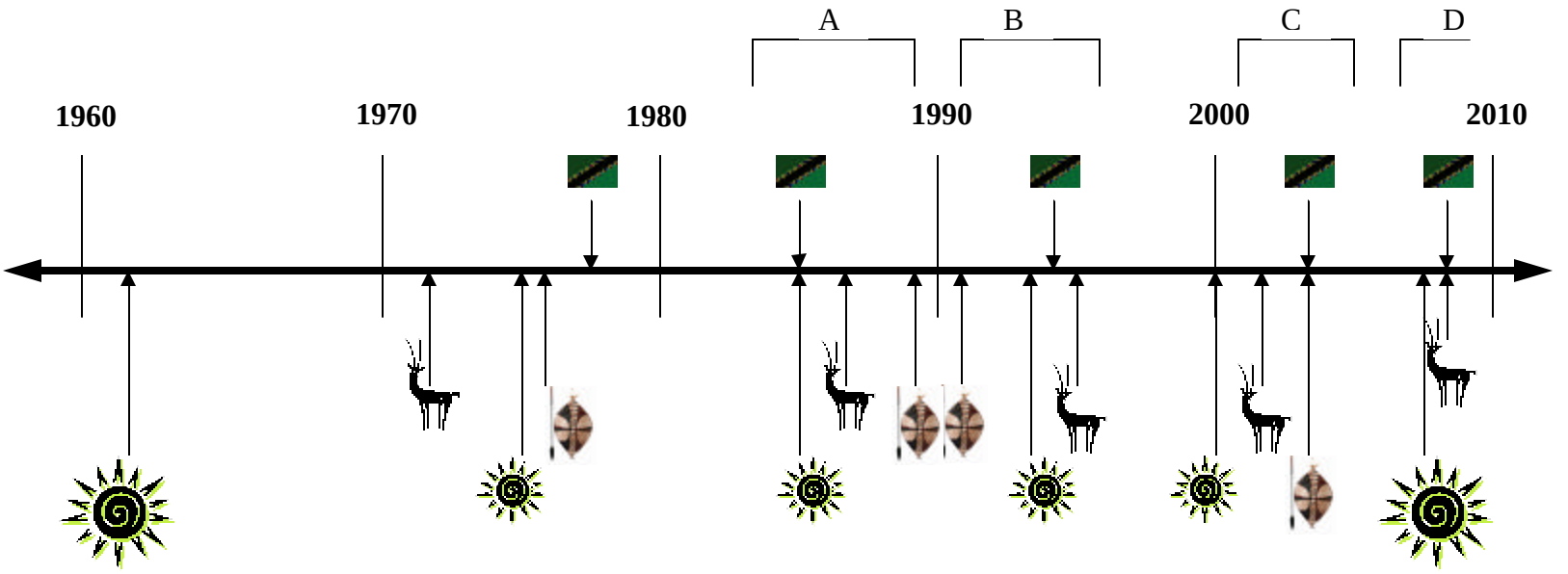
The Maasai of Tanzania have been watching their traditional territories shrink for nearly all of the last century. Starting with the Maasai Reserves, demarcated by both the German and British colonial powers to clear land for European settlement and wildlife

[29] Early in my fieldwork, the first photosafari operator to lease Loiborsoit lands told me he worried an agricultural development organization would drill a borehole on the plain, thus opening the area to settlement. Ironically, his successor drilled that borehole less than 6 months after this conversation.

conservation, Maasailand is now less than half of its pre-colonial range (Ndagala 1997). This compression of pastoral territory has removed the flexibility and spatial extent necessary for livestock rearing in environments of inconsistent rainfall and patchy resources (see Chapter 4). This has resulted in declines in wealth and the ability of families to survive on cattle alone, irrespective of population increases. Thus land loss and poverty can be seen as closely correlated. The intertwined narrative threads make it difficult and somewhat artificial to separate the two issues. One way to integrate these forces is to examine their relationship in conjunction with historical abiotic and cultural events.

There appear to be moments when national and international attention on Simanjiro has coincided with livestock-killing droughts, economic uncertainty and milestones in Maasai age-set politics, intensifying the reaction to tenure insecurity. Most critical are three time frames clustered after droughts in 1984, 1994 and 2000 (Figure 2.3). The Simanjiro Conservation Area was first proposed in the mid-1980s: it recommended forced herd reductions when herd sizes were already low due to drought conditions and yet subsistence requirements were also increasing as Maasai became integrated into the cash economy (Cluster A). Additionally, following a Structural Adjustment Program (SAP) in the mid-1980s dictated by the IMF, the national government was facilitating the allocation of large tracts of pastoral land to speculators and large scale agricultural interests (Igoe and Brockington 1999, Shivji 1999). Caught between the wildlife and agricultural industries, newly-minted (and politically savvy) junior elders staged the secession of Loiborsoit in 1989, subdividing the land to solidify

**Figure 2.3 Timeline of events influencing land use decisions in Loiborsoit. Note clustering (A-D)**




**Key:**

Maasai age-set events……

Drought / Disease (size of symbol reflects intensity)……

Conservation initiatives……

Government policy ……

Maasai land rights, much as their elders had attempted to do during villagization 10 years earlier.

The secession of Loiborsoit village from Emboreet also coincided with the push by the Arusha Diocese Development Office (ADDO)[30] to demarcate and map village lands (Hodgson and Schroeder 2002). Based on the premise that creating nucleated space would help pastoralists protect their lands, the Diocese used a model (the village) of tremendous historical and emotional traction in Tanzania (ibid). However, when enmeshed with traditional Tanzanian law requiring land to be 'improved' ('altered') in order for residents to prove rights to the land, the creation of villages and demarcation of territories has added new levels of complexity and confusion to the landscape of political rights in Maasailand. One of the often quoted subtexts to land loss in pastoral areas is its apparent lack of habitation (Ndagala 1997). Tanzanian law is based on colonial British law which requires land holders to 'improve' the land they own in order to claim it. This puts the burden of proof on the heads of land users to physically show they have rights to traditional lands. Without such proof, land can be taken away and reallocated to other individuals. The fear of losing their remaining territory to non-Maasai interests and land-users has driven both past and present land-use choices at the village level, using new governmental structures and non-traditional land-uses to maintain the Maasai character on the landscape.

The Landis age-set, the *ilmurran* (warrior) class at the time, had only recently gained economic access to cattle when livestock numbers rapidly declined in the 1990s, increasing their sense of impoverishment (Cluster B). The collapse of the Tanzanian

[30] ADDO is a religious non-governmental organization associated with the Catholic Church mission in Arusha.

economy led to the loss of national veterinary support for livestock vaccination and the maintenance of cattle dips for application of acaracides or insecticides, thereby contributing to increases in cattle mortality and subsequently exacerbated by the drought of 1994 (Hodgson 2001). Government-imposed constraints on flexibility and mobility and increased anti-poaching initiatives limited the traditional coping mechanisms of migrating to other pastoral regions or falling in with bands of Dorobo hunter-gatherers. Prior to the creation of TNP, Simanjiro Maasai used portions of the protected area as a drought reserve in times of need; in 1994 the dry season lasted longer than in 1984 and the loss of those well-watered lands was keenly felt. This reduction in traditional risk mitigation strategies coincided with a revived concern over the sale of Loiborsoit land to outsiders (Lewis Lama, personal communication), and a renewed interest in mapping by researchers affiliated with TANAPA (TCP 1997). After this, even though the Landis *ilmurran* had regained some sense of economic security from their involvement in the lucrative Tanzanite industry, fear of both land loss and increased cattle diseases kept them from investing in livestock, leading to a second wave of land transformation as young men diversified into cultivation. With the allocation of land to agriculturalists by national politicians, it seemed clear cultivation was the future—as several young men told me: *"Even Nyerere*[31] *said we should hold cattle with one hand and the hoe with the other."*

The most recent period of intense conflict over land management began with the drought of 2000 and was extended by the terrible drought in 2006 (Clusters C and D). The impact of both droughts was probably intensified by increases in both livestock and human densities, but the creation of the new Manyara region in 2002, and continued

[31] Julius Nyerere was the revered first president of Tanzania.

concern over land transformation from the wildlife sector, combined with poverty concerns to convince local authorities that all land allocations needed to be farmed or they would be re-allocated to outsiders. Certainly the inability of Maasai to gain access to former drought pasture reserves inside TNP escalated Maasai frustration and decreased their willingness to negotiate with the wildlife sector over new conservation projects in the Simanjiro plains. The response to this came in the summer of 2006, when the Regional Government sided with wildlife agencies that 'uncontrolled' agriculture had gone too far: a 3-year moratorium on new farm allocations has been set (AWF 2006). A new zoning plan is being discussed and developed, after which a grazing area much like the SCA may be established under the proposed Wildlife Management Area rules (AWF 2006, Goldman 2006). Coming off of the worst drought in 55 years with high livestock mortality, Loiborsoit residents are understandably concerned for their futures. Mistrust of local and national elites, and of conservationists and researchers, has skyrocketed as the tension has risen. This situation is only repeating a chain of events already seen multiple times since the creation of TNP.

***The Maasai Model***

Desta and Coppock (2004) refer to declines in per capita livestock holdings and socio-economic changes brought about by population pressure as the 'Maasai model,' based on long term research among the Maasai in Kajiado District, Kenya. They break the model into six components; decline in cattle/people ratio, need to seek food resources to augment decreasing milk resources, increased pressure to control or privatize resources due to resource competition (including competition with wildlife preservation), loss of key grazing and water resources to land annexation and environmental degradation, a

shift to smallstock relative to cattle and rising poverty and food insecurity. These then set the stage for either wholesale emigration of pastoralists from the region or diversification of household economies to guard against risk. Most of these components can be found in the Simanjiro case study as outlined above, leading me to surmise that the Kajiado Maasai 'model' is applicable for the Simanjiro Maasai, whose changes have occurred within a very different political framework. However, Desta and Coppock claim the ultimate internal driver of these changes is human population growth and therefore focus their analysis on the first aspect of the model, declines in per capita cattle holdings due to natural constraints and human population growth. Population has increased in both Loiborsoit and Simanjiro as a whole: the ratio of cattle to people has declined among pastoral households and the proportion of smallstock to cattle has increased while the area available for pastoral production due to cultivation, conservation and immigration has decreased. Yet qualitative interviews suggest the adoption of cultivation originally began for reasons beyond decreases in milk production. In Loiborsoit, these reasons encompassed more than individual wealth concerns: it is clear that land tenure insecurities stemming from both past and present land loss and insufficient government support for pastoral land-use has been a major force behind land transformation.

Despite the correlations between land losses and livelihood change, it is important to understand the underlying drivers if wildlife conservationists are to attempt negotiating access and opportunity for wildlife in Simanjiro. Because these drivers impact different levels of decision-making, solutions failing to address *both* economics and land tenure are doomed to failure. Wildlife conservationists have tried a number of tactics over the years to turn back the tide of cultivation in Simanjiro. Unfortunately, without addressing

both household economies and generalized fear of land alienation, these tactics have not been successful. The drivers of livelihood change in Simanjiro are *heterarchical*, not *hierarchical;* solutions aimed at one level cannot be expected to resolve conflicts and concerns at lower levels (Crumley 1994, 2006, Balee and Erickson 2006).

Heterarchy is a term borrowed from cognitive psychology (McCulloch 1945) and used to study complex networks in a number of fields, including the archeology (Crumley 1994, Balee and Erickson 2006, Becker 2004) and economics (Stark 2001). In a hierarchy, elements of a system are subordinate to other elements at higher organizational levels. Alternatively, heterarchical systems have potentially unranked or flexible elements which can be reorganized to meet the needs of the system or the situation (Crumley ibid). The socio-ecological system of Simanjiro, and the greater TME, contains hierarchical organizations, i.e., the Tanzanian judicial system, the Region-District-Ward-Village governmental structure. But these hierarchies are embedded in a heterarchical world, in which interests at each organizational level interact with climatic conditions, household economies, neighborhood disputes, the international wildlife preservation community and local wildlife conflicts. Stresses on smaller elements in the system, household economies, for example, can have reverberations on the willingness of village leadership to enforce national government regulations. Revenue-sharing schemes do not cover the immediate loss of harvests to wildlife predation or the impact of not being able to farm on household subsistence. At the same time, each individual is also a part of a collective ethnic, not just regional, Maasai entity, with its own desires and concerns. Efforts to ostensibly protect the land interests and pastures important to Maasai pastoralists from agricultural expansion, as in the SCA or the Wildlife Management

Areas currently under discussion (Goldman 2003), fail to convert the Maasai, who view these proposals as attempts to complete the appropriation of collectively held Maasai land. For all the hand wringing in conservation circles over the transformation of pastoral landscapes and the blame placed on population growth, very seldom discussed is the role of conservation in squeezing the Maasai (and the agriculturalists) into smaller and smaller spaces, in effect creating density and conflict. The complexity of these interactions, spatial, temporal and social, must all be considered when designing effective land-use policy.

## CONCLUSION

As conflict increases at the interface of protected areas and local livelihoods, it is critical to understand the dynamics of local land transformations in order to craft realistic natural resource policies. In Tanzania, many of these interfaces also mark a cultivation frontier, as formerly mobile pastoralists integrate settled agriculture into their subsistence system. Observers debate about the drivers of this transformation: is it a form of risk management as pastoralists become increasingly impoverished or is it a result of land tenure insecurities? In this paper I have examined the dynamics of these interrelated drivers for a Maasai village on the agricultural frontier on the Simanjiro Plains and conclude that both poverty and land tenure insecurity are operating in this village, interacting across temporal, spatial and social scales. Temporally, these include the long term trends in population movements and land tenure insecurities based on historical experience, as well immediate moments of decision making. Spatial scales span regional territories, local pastures and distances from the national park and corridor regions. Maasai society itself is both spatial (sections versus subvillages) and temporal (age-set

dynamics). Individual decisions can be impacted by these different scales differently than village level decisions. The complexity arising from these interactions implies that resource management efforts failing to integrate both factors into their policy solutions will have limited success and possibly exacerbate, rather than alleviate, tensions over land-use.

Poverty alleviation and land tenure decisions occur at different organizational levels, requiring different data sets and suggesting different theoretical dynamics. I used data addressing the problem from two theoretical perspectives: intensification theory, based on individual choices of farmers and household level economics, and political ecology, which also examines the situation through the eyes of the land user but recognizes the impact of larger-scale social pressures and power inequities on land-use choices. Traditional intensification theory expects the actors to be operating with full knowledge—i.e., they are the experts. The Maasai clearly do not know much about farming, but are experimenting with it, learning from cultivators and expatriates while hoping to stay ahead of threats to their occupation of traditional lands. Poverty is a serious issue in Loiborsoit: nearly 80% of the village population cannot feed themselves on cattle alone, either through milk production or sale of animals. Falling livestock ratios, resulting from both population growth and increased livestock mortality, and the shifting emphasis from cattle to smallstock are indicators of a traditional economy under serious stress. Nor can the rising demand for goods and services be left out of the discussion. Yet while economic insecurity is certainly a driver in household decisions in Simanjiro, the level of uncertainty in their legal right to historical lands is intense.

Political ecology approaches have much to offer the study of land use intensification, particularly as international movements can make tremendous impact in far corners of the world. Its emphasis on scale and complexity, power inequality and decisions made under uncertain conditions can produce a more nuanced, contextual analysis of the conditions driving land transformation. This study suggests that the traditional view of subsistence-level agricultural intensification may not be sufficient in the case of agricultural change among pastoral people. Instead, pastoral land-use change in Maasailand is driven by economic and political factors at multiple social and spatial scales: economic factors are of greater importance to individual households and decision-makers while political factors may come into play at larger aggregates of individuals, sub-villages and villages as well as age-sets.

Taken together, these lines of analysis suggest that policies which take into account this complexity and potential for flexibility will be most likely to succeed. Adaptive management (Rogers 2006) is one model of land-use planning and monitoring which is recognized as taking social and ecological uncertainties into account and might be a model for future research and policies. Remittances to villagers for *not* farming the land also have the potential to support livestock and alleviate poverty. These payment schemes have shown potential in villages with enough land to support both farming and non-farming sections in critical conservation zones. Unfortunately, land tenure insecurities make remittances difficult to organize and implement. Any productive policy will require careful and frequent renegotiation of accepted goals and realities with multiple stakeholders, including those for whom the goals of wildlife preservation are both a nuisance and a hindrance to personal survival. Building flexibility and complexity

into the planning process, in effect mimicking the strategies used by both human and wildlife residents on the savanna, may indicate a way out of the cyclical pattern of drought, economic decline and land fragmentation outlined in this paper. As fears continue to rise with the recent land-use restrictions on the Simanjiro Plains, this may be a creative avenue for residents, researchers and resource users to explore in the future to minimize conflict and suspicion among all resource users.

# CHAPTER 3

## COMPRESSING THE COMMONS: EVOLVING HERD STRATEGIES

### INTRODUCTION

*In the future, my children will live like WaSwahili (non-Maasai); they will be educated, be 'developed'. But cattle will still be important, they will still be Maasai.*

-Maasai elders (*Irkishumu* age set)

These elders are speaking of the paradox inherent in their attempts to be modern pastoralists—how can they be 'developed' and yet maintain their traditional role as 'people of the cattle'? In East Africa, these distinctions and contradictions are the subject of much discussion (O'Malley 2001, McCabe 2003, Thompson 2002, Ndagala 1997). The implications of this dilemma are of concern to the conservation community (TCP 1997, Lamprey and Reid 2004), anthropological and human rights groups (Campbell 1993, 2000, Thompson and Homewood 2002, Igoe and Brockington 1999), and development agencies (Muir 1993, Maitima et al. 2004). Many of these sources raise concerns over the commitment of Maasai to being people of the cattle and a concurrent concern over the state of the rangeland wildlife utilize during their yearly cycle.

Research into dryland ecology over the past decades suggests that supporting mobility and flexibility in pastoral production systems are appropriate development goals for both ecological and social rationales (Niamir-Fuller and Turner 1999, Behnke and Scoones 1993, Scoones 1995, Little and Leslie 1999). Pastoralism is a production system based upon livestock herding. Usually found in ecosystems with limited or stochastic

resources, pastoralists must be able to follow rainfall or specific pasture resources throughout space and time in order to meet the needs of their animals. Unfortunately, maintaining mobility under conditions of political capriciousness and population growth is not easy, and pastoralist people across the globe are becoming increasingly sedentary as their lands are fragmented by protected areas, development projects and settlement schemes (see Chapter 2). It is difficult to provide modern social services, such as education and health care, to mobile populations, and many developing countries feel mobile populations detract from the image of a modern nation-state. However, long-term environmental sustainability may depend on translating such contradictions into policy.

In the 35 years since the creation of Tarangire National Park (TNP), the Maasai Steppe and Simanjiro Plains have been fractured by large commercial farms, villagization,[32] and development (Muir 1993, Ndagala 1997, Igoe and Brockington 1999). These developments have led to considerable change in the grazing systems of local herders. Maasai in these villages now contend with in-migration and intense land-use change, all while reorganizing their grazing and resource regimes to meet the changing spatial and social environment. Perhaps the most critical transformation has been the compression of Maasailand from vast pre-colonial territories to village level spaces (Ndagala 1997). Retaining flexibility and mobility in the modern grazing system within this smaller, fragmented landscape with many different land holders is a major obstacle to the continuance of the pastoral lifestyle and the maintenance of the savanna environment. Ndagala (1997) suggests zoning systems may provide a level of tenure security for pastures that can be molded around traditional resource arrangements, yet the scale of

[32] Villagization is the English term for the rearrangement of Tanzanian lives around communal villages. Called Operation *Imparnati* in Maasailand (see Chapter 2).

zoning plans are problematic: village level zoning schemes cannot fully contain the variety and spatial area needed to adequately support herds in all years (Turner 1993).

The village of Loiborsoit A is located on the northwest corner of the Simanjiro Plain and borders TNP. It has a zoning plan, with extensive pastures and areas for development and mixed farming. Loiborsoit is therefore an excellent case study of both the suitability of the zoning model and changes in common pool resource (CPR) regimes as pastoralists settle. I believe the zoning system has offered most Loiborsoit residents enough grazing land for most seasons, including many of dry years. Yet the focus on the village as a socio-ecological unit has failed the Maasai—not only do many herders regularly utilize specific range resources in neighboring villages, many herders from across the Maasai Steppe depend upon Loiborsoit rangelands. This chapter addresses this conflict, first by specifying how herders in Loiborsoit have modified their traditional grazing and tenure systems to fit within the village boundaries and secondly, questioning the suitability of this new grazing plan for the survival of pastoral livestock herding in Simanjiro. I begin with a short introduction to common pool resources and their importance to resource management, followed by a review traditional Maasai property regimes and resource use as described in the literature and by Maasai informants. I then identify the current grazing system and tenure structures which continue to create new boundaries and levels of pasture access based on fieldwork, describing patterns of use over both daily and yearly grazing cycles. Finally, I address the implications of the fragmentation of traditional common pool resources for both pastoralism and wildlife.

**COMMON POOL RESOURCES**

Both mobile and sedentary rural livelihoods in Tanzania depend heavily on common pool resources (CPR). Common pool resources tend to be large or amorphous, therefore difficult for an owner to protect and exclude other users from removing the resource (Ostrom 1999). Such resources can be managed within three broad frameworks: government, private or common-property ownership (Dolšak and Ostrom 2003), but may be most efficiently regulated by a group of people working together within a common property framework. In East Africa, CPRs include water, forest products and pastures (Lovett et al. 2006); these resources are managed within a system where owners share a resource, restricting it from use by outsiders. Restrictions can be circumvented within the system by flexible reciprocity agreements between parties, particularly in times of stress. By maintaining reciprocity networks and relationships between users of communally owned resources, individual households can temporarily access those resources in times of stress. One key point is the temporary nature of outsider access: when conditions improve the pressure on resources is lessened and rangelands are able to recover from additional grazing pressure. In the mostly arid and semi-arid rangelands of East Africa, where resources are patchy in both space and time, this flexibility is critical to survival.

Many environmental problems have been blamed upon misuse of CPRs. These problems are thought to be a result of the Tragedy of the Commons[33], a scenario based on Garret Hardin's influential article in *Science* (1968). Hardin used the example of herders grazing livestock on commonly held pastures to describe a situation where the rational person would need to continue to add animals to the commons in order to capture the

[33] Resources held communally (that is, under a CPR regime) are frequently referred to as 'the commons' in the literature.

resource or else risk losing the resource to others less scrupulous than he. Many studies of pastoralism in the wake of his article have refuted this example (McCabe 1990, Homewood and Rogers 1991, Turner 1999, Lane and Moorhead 1994). Researchers have noted the tragedy scenario depends upon a property regime in which anyone is able to utilize the commons, a system referred to as open access. By definition, a commons is a CPR managed by a group for their own use, therefore not an open access system. Despite Hardin's correction of this misclassification (Hardin 1994), the imagery persists and underpins many pastoral development and wildlife conservation interventions. These interventions fragment the commons for privatization in the name of sustainability and environmental protection (Hoben 1976, McCabe 1990, Fratkin 1997, Brockington 2002).

The significance of CPRs can span and encompass many social and environmental levels; a pasture held in common might be important for biodiversity conservation of endemic species, watershed conservation and human survival through protection of unplowed lands for livestock grazing. Notwithstanding the importance of CPR in rural Africa, there is a wave of privatization occurring across the African continent (Lovett et al. 2006). This should be a concern to ecologists as most of the continent's biodiversity exists on communally held lands. Across Africa major wildlife zones overlap areas of traditional pastoral commons (Homewood and Rogers 1991). Even animals residing in protected areas frequently depend upon pastures beyond the boundaries of protected areas during part of the year, usually during the rainy season (Kahurananga 1979, Homewood and Rogers 1991, Homewood et al. 2001, Mwalyosi 1991). Privatization and subdivision of formerly communal lands is thus a serious threat to the sustainability of the park system (Borner 1985, Gamassa 1989). Subdividing the

rangelands not only impedes the mobility of livestock and herders but also of wildlife populations found in these areas (Borner 1985, Mwalyosi 1991 & 1992). Ironically, the creation of protected areas in former pastoral ranges has exacerbated the problem (Chapter 2, Homewood and Rogers 1991, Igoe 2004). By splitting the larger rangelands, the establishment of protected areas removed a critical resource from pastoral use but not wildlife. The development of new CPR regimes is then also important for pastoral societies as they negotiate grazing resources within new social boundaries and increasing impediments to mobility. Maintaining open ranges instead of subdividing remaining territories can allow pastoral societies to maintain traditional production systems suitable for local environmental conditions and support community members who might not have access to the capital needed to settle and plow the land (Lovett et al. 2006, Lane 1998). This may be especially true in areas located on the environmental margins of subsistence.

Due to the importance of traditional commons for rural populations, developing new CPR regimes to protect natural resources under changing environmental and societal conditions may therefore be critical for sustainable resource use in many situations (Dietz et al. 2003). Common pool resource regimes are characterized by the nature of the resource and the institutions in control of the resource (Oakerson 1992, Ostrom 1990). The interactions of these characteristics enable us to evaluate the sustainability of the system and its potential outcomes. When the CPR and its organizational regime are evaluated together, the system being examined is one form of a socio-ecological system (SES), a system integrating humans with their landscape, or humans-in-nature (Berkes and Folke 1998). The loss of mobility and the creation of hard boundaries in a pastoral system would indicate a reduction in the resilience of the socio-ecological system (Turner

1999). Resilience refers to the ability of an ecosystem to absorb the impacts of disturbance without changing the basic structure of the system (Holling and Gunderson 2002). A resilient ecosystem can adapt to disturbances but as resources become locked up, flexibility is lost. The system becomes brittle and the probability of a new ecosystem structure, one very different from the original, becomes increasingly likely. In this paper I describe the evolving common property regime of Maasai herder-farmers in northern Tanzania in order to evaluate the robustness of the system for the maintenance of open space on which both livestock and wildlife depend.

## THE CASE STUDY SITE: LOIBORSOIT-A VILLAGE

The village of Loiborsoit-A is located on the edge of the Simanjiro plain, an ancient uplifted plain of gneiss baserock located in the geologic Mozambique belt dating from 600 million years ago (Schlüter 1997). To the north and west is the southern end of the Gregory Rift of the East African rift valley system; roughly 14 miles north of Loiborsoit administrative center the rocks and soils become volcanic. From the village, Mts Kilimanjaro and Meru, the first and third highest mountains on the African continent, can be seen on a clear day. Between the mountains and the plain is dry thorny scrub. The plain itself is roughly 600 $km^2$ with altitudes between 1300-1600 meters above sea level (masl). To the immediate north of Loiborsoit is *Oldonyo Lokisale,* a hill reaching 2132masl. Lokisale's dry season river beds mingle with those that flow off of the plains to give the northern portion of the village steep ridges and deep sand rivers. The western portion of the village drops along fault lines to the boundary of Tarangire National Park (1220 masl). The central part of the village, the shops, churches and school (1567 masl) is located at the edge of the rolling plains to the south and east and the dolomite ridges of

to the north. The name of the village, Loiborsoit, means white rock in the local Maa tongue and refers to the marble/dolomite outcrop near the administrative center of the village.

Kahurananga reports an average yearly rainfall of 600mm based on over 30 years of records kept at the Catholic Mission south of Loiborsoit[34] (Kametz 1962, mimeograph cited by Kahurananga 1979), although Peterson (1978) reports slightly less averaged over 11 years in Loiborsoit. This is squarely in the transition zone (650mm ±174 mean annual precipitation) between stable savannas, those which do not need disturbance to maintain open grassland, and unstable savannas which require fire or herbivory to maintain its characteristic grass-woodland mosaic (Sankaran et al. 2005). Water availability is the primary constraint on savanna productivity and structure. The driest soils in East Africa are dominated by thorn scrubland, the wettest by forest. Intermediate zones are grassland. Along this rainfall continuum, variability in rains, soil water holding capacity and water penetration are correlated with changes in species composition and productivity (Belsky, 1995). Watercourses, depressions under ridges and seasonal water channels all support tall and green vegetation, even when the rest of the region is dry. Water distribution also defines the distribution of human resource populations on the savannas. Pasture use of the plains is limited to the rainy period when water stands in natural puddles, seasonally inundated floodplains and small water catchments built by the Parakuyo Maasai, who lived in Simanjiro before the Kisongo. Loiborsoit's pasture resources encompasses at least 4 vegetations types: short grassland dominated by *Digitaria macroblephara* and *Pennisetum coloratum*, low canopy woodlands in the ridged zones dominated by *Acacia nilotica* and *Commiphora spp*, and seasonally

[34] This Mission is probably the one in Emboreet.

waterlogged bushed grasslands dominated by *Pennisetum mezianum* and *Acacia drepanolobium*. In the western portion of the village, the vegetation is dominated by high canopy woodland consisting largely of *Acacia tortilis* and *Commiphora schimperi* (Kahurananga 1979). Local names frequently reflect locally dominant tree species, such as the sub-village Mbuko, which contains many *Embukoi* (*Terminalia brownii*) trees along steep drainage channels (*korongo*).

***Methods***

This chapter addresses two questions about the altered grazing system in Loiborsoit village. First, how has the common property regime been altered by the fragmentation of the pastures? Secondly, Loiborsoit territory has been rescaled to fit a zoning plan based on the village—how suitable if this model for pastoralism, both socially and environmentally? Data were collected through personal interviews of herders living in 79 bomas and periodic visits to bomas within the larger sample in order to determine seasonal food production activities. The periodic interviews were undertaken largely to ensure awareness of variability in herding and agricultural parameters. An attempt was made to reach each subvillage every 2 months to gather this data. Overall, these interviews are an opportunistic sample, both temporally and spatially; when extra time was available after longer interviews or vegetation survey we would attempt to interview any neighboring boma within our sample. As such, the sample is not truly representative for all months and locations, although the 332 interviews covered 16 months and all sub-villages were visited during most months. The dry months of June-July 2002 were particularly under-sampled as they were months of low agricultural activity and high bureaucratic responsibilities requiring me to spend

extensive periods in the capital city of Dar-es-Salaam, on the coast of Tanzania. These months are relatively early in the dry season; while forage may be increasingly limited, the situation would not be as extreme as later in the dry season so the overall bias in my data is probably limited.

Herding activities are coordinated at the boma-level. A boma is a group of households who lived together largely for the purpose of sharing labor for herding duties. Herders were asked where their boma's livestock were currently grazing on watering and non-watering days, covering the two-day grazing cycle. These answers were then coded to fall within one of the pasture zones I describe below and split into two groups, grazing within demarcated pastures and grazing beyond the official pastures. Rainfall during the period of fieldwork was considered average (600mm/per year), an environmental parameter that certainly impacts pastoral (and agricultural) activities in such a varied climate. Season and pasture use, demarcated pasture use or beyond village pastures, was then transferred into the statistical package R (R Core Development Team 2006) for analysis using the *survey* package (Lumley 2006) for a single stage stratified cluster sampling design. This was done to quantify the how frequently pastures under different management were used over the research period. This measure lends support to conclusions about the suitability of the zoning model for Loiborsoit herder-farmers as well as its long term prospects for sustainability.

### *Historical Resource Use of the Maasai*

Pastoralists are dependent upon a range of communally controlled resources, mainly pastures, water and forest products. In order to understand the changes in resource use since the advent of colonialism and the creation of political boundaries in

previously unbounded space, it is first necessary to examine how Maasai historically managed their resources. The focus of this chapter will be on pasture and water, which are spatially correlated. Water that is available without effort on the part of people (natural pools, puddles) is available to everyone. Wells and small dams, which require hard labor to create and maintain, are owned and maintained by specific clans or occasionally an individual. The pastures around these water sources are therefore logistically limited to those with legitimate ties to water access.

Traditional organization: Time, Blood and Space

Because pastoralism requires adequate forage in unpredictable rainfall, one way Maasai minimize risk is through their social institutions. Maasai define themselves in three ways: space, time and kinship. Modern Maa-speakers are divided into two main groups, the Samburu and the Maasai. The Maasai in turn are divided into smaller territorial units called sections, or *olosho* (singular, *iloshon*). The number and identities of the *olosho* have changed over the past several hundred years, due to famine, disease and war. *Olosho* are spatial units, a social group who control a territory of pastures which contain most (if not all) the critical grazing resources needed for pastoralism (see below).

The most famous social institution among the Maasai is the age-grade system (see Spencer 1993 for long description). One of the most important ways of being Maasai is to be initiated into an age-group, through circumcision. When a boy is circumcised, usually when he is between 14-20 years old, he enters a warrior (*murran*) class in which he will stay for 7-14 years. Historically, there were 2 age-sets with each age-group, a left-hand group and then seven years later a right-hand group, who were merged during

the *Oln'gesher* ceremony to become junior elders. Today, at least in Tanzania, this practice has been abandoned and only one group of warriors is established. The *Oln'gesher* ritual is still celebrated roughly every 14 years and closes out the period of *murran*-hood. These men then become junior elders until the following age-set retires from warriorhood and become junior elders in turn, thus pushing older age-sets up the ranks. The role of the *murran* is both protective and economic: they protect herds from wildlife, disease and hunger, transport them to markets and are increasingly involved in wage-labor. Elderhood was, and is, for politics and wealth accumulation: the junior and senior elders do much of the day to day politicking and decision-making even today.[35]

By splitting Maasai life both spatially and socially, it is possible for a Maasai to access resources and assistance both locally, from members of one's own neighborhood, and far away (if necessary) through members of the same clan or age-set. Traditionally special warrior-settlements were kept to introduce warriors to each other and to keep far-flung members of a section abreast of environmental and societal conditions across the territory.[36] Kinship ties the entire structure together: while most Maasai in Tanzania belong to a single *iloshon*, clan groups cross through all spatial boundaries. All Maa-

[35] In fact, the interplay between elders and warriors is one of the basic facets of Maasai political life. Older warriors are usually eager to become elders, to marry and take on the political roles while the elders may be reluctant to give up their roles as the political leaders. This interplay has played an important role in the history of East Africa throughout the colonial years (and probably before) (Spencer 1993).

[36] Cities and markets serve the same purpose today. There are guesthouses, bars and *hotelis* (small restaurants) in Arusha that cater largely to Maasai and even to certain districts of Maasailand. When I am in Arusha, for example, I know that if I need to get a message to anyone in Loiborsoit, I can run by the Eden Bar, where every day at least one vehicle will be carrying passengers to Loiborsoit and the driver can carry a message to the village. Alternatively, there is a *nyama choma* (barbeque) place a few blocks away that caters largely to the men working as middlemen in the Tanzanite gemstone industry, mostly Maasai warriors and junior elders (see Chapter 2). So despite all of the changes in Maasai society in the last century, including the compression of territory and the loss of the right-hand warrior group, overall the social stratifications by age and location remain integrated and useful to the modern Maasai.

speakers belong to one of two moeties, the Black Bull (Mollel) or the Red Bull (Laizer). Each moety is then split into a series of clans. Marriage is done across clan lines, and often men will travel far to obtain brides. Maasai are polygynous; therefore a household can theoretically have access to help from many families when disaster strikes. When it is necessary to move in search of pastures, or increasingly land for settlement, both affinal kinship ties and age-set relationships are called upon.

Traditional grazing territories

Pasture access within *iloshon* was historically controlled by smaller levels of organization, the locality, or *enkutoto* (O'Malley 2001, Jacobs 1965). Elders at this level worked together to organize grazing and watering schedules within their regions. The elders decided when and where to move, when to return to dry season pastures and when drought reserves were broached (Igoe 2004, O'Malley 2001). Drought reserves were frequently shared by many *enkutoto.* During very bad years, if resources became scarce in an area, permission was requested by others of the same *iloshon* for access to their territories. Geographic location and custom limited access to grazing lands and water as much as social mores (Igoe and Brockington 1999). Water, on the other hand, was controlled within a territory by clan membership. If water became scarce, one could request permission of a clan whose water source was plentiful but generally only within the *iloshon* (Jacobs 1965).

While frequently portrayed as nomadic herders, Maasai were never true nomads but rather followed a transhumant herding pattern, alternating between wet and dry season pastures.[37] Their grazing pattern was based on a 'point-centered usufruct system'

[37] Nomadic pastoralism is generally limited to extremely dry environments, such as the Sahara Desert (Igoe 2004).

common to African pastoralism (Turner 1999), where access and use of pastures is based upon the locations of homesteads and encampments, as opposed to spatially bounded and demarcated pastures. During the dry season herders lived in homesteads near persistent water sources. Herding during this time was restricted to a day's journey away from the homestead, which was itself only a few miles from the water source. Cattle were limited to drinking every other day, alternating water days with other homesteads in the immediate area and grazing away from the water on off days. In this way, the pastoral herds of hardy zebu cattle and smallstock were able to survive the dry season.

Grazing in the rainy season centered on areas marginal for cultivated agriculture with little (if any) permanent water, but with forage of high nutritive value. These ranges were necessarily larger than the dry season pastures because rainfall is frequently a spatially patchy event, seldom covering an entire area. In well-watered regions this characteristic is not limiting as there are sufficient rainfall events to cover the area, but this patchiness drives dryland ecology because in semi-arid and arid locations, vegetation is closely correlated with moisture (Belsky 1995). A specific spot may only receive a few millimeters of rain a season, so vegetation sprouts up quickly after rainfall to take advantage of the moisture, while the surrounding areas may remain dry. Because of this characteristic of savannas, herders needed mobility and space to take advantage of flushes of forage wherever they might occur. During the rainy season they built temporary bomas to protect herds from wildlife. Dry season areas were often of greater agricultural potential as cropped lands due to permanent water sources, and sometimes more reliable rainfall, but pastoral production was (and continues to be) the most

productive use of wet season pastures unsuitable for continually cropped cultivation due to low and patchy precipitation (Hoben 1976).

Drought Reserve

An important component of the traditional grazing system was a protected grazing zone located beyond the normal wet and dry season pastures. This pasture reserve was protected from the normal yearly grazing rotation by tradition and social sinecure. Drought is common in most of the Maasai traditional territories, therefore the reserves include fairly large areas around permanent water which set aside only for use during the driest years. This is an extremely important feature of the traditional grazing system, yet was the first to be made inaccessible due to the creation of national parks and commercial farms which centered on these permanent water sources (Hoben 1976, Igoe 2004, Lane and Moorehead 1994). Between Europeans who wished to live conveniently near water resources and wildlife preservation groups who wished to protect game during the dry season, drought reserves were progressively appropriated. This left all pastoralists in East Africa increasingly restricted to smaller and smaller pastures. Unable to rotate their herds, they are now forced to graze all year on the most seasonal pastures and at higher densities than prior to colonization. This has had significant social and environmental implications for the continuity of pastoral livelihoods and, by extension, wildlife populations sharing the range.

Simanjiro

The traditional grazing regime in Simanjiro followed this general pattern. There is only one *iloshon* in the area, the Kisongo, who cover most of Northern Tanzania. In the wet season, herders would spread across the Simanjiro Plains. During the dry season

they concentrated around a series of wells and dams that have been in use for centuries.[38] The major drought reserve south of the Crater Highlands was the Tarangire River and nearby Silale Swamps. In 1957 this region was made a Game Reserve (GR), where hunting was forbidden, yet Maasai were still allowed to graze their livestock in the GR, a fact especially important during the extreme drought of 1960-61 (Lamprey 1963, Igoe 2004). In 1972 these permanent water sources were removed from the Maasai resource base through the creation of Tarangire National Park (TNP), which enclosed normal dry season pastures as well as the drought reserve. The loss of this area forced all of the Maasai formerly using those dry season ranges to live all year around on former wet season grazing lands.

***Current resource use***

Shortly after achieving independence from the British, Tanzania set out a system of African socialism centered on the concept of *ujamaa*, or togetherness. Using the village as the basic unit of production, Tanzanians were encouraged (and later forced) to renegotiate territories and agricultural tasks to increase productivity. When this process of villagization failed, the Tanzanian government began a program in the late 1980's to give all villages in the country title deeds. Each village was then able to issue sub-titles to village members for personal use. The national government hoped that registering and titling villages would lead to greater agricultural productivity (Lane and Moorehead 1994). These gains in productivity were expected to grow from increased land tenure security, even though the most productive pastoral lands had already been removed from

[38] Many of these dams were created by the Parakuyo Maasai, Maa-speaking agro-pastoralists forced out of the Simanjiro Region 200 years ago.

their resource base. Overall, the program has had mixed results. Many villages in Simanjiro do not yet have the promised title deeds despite their desire to obtain them[39] (see Chapter 2).

As a part of this titling procedure, villages have been encouraged to develop land-use plans. Loiborsoit's land-use plan splits the village territory into pasture and mixed use zones, based upon water availability at that time. The pasture zone section had no permanent water sources and its farther reaches were tsetse infested. The mixed use zone is broken into 9 sub-villages (*kitongoji*, sing; *vitongoji*, plural), one of which is the village center (Madukani), and only contains 1-2 acre town plots (see Figure 3.1). Most of the non-Maasai village residents live in this *kitongoji.* There is one borehole in this portion of the village, theoretically only available for human use but in practice smallstock and calves are watered there during the dry season. The remaining *vitongoji* cover both the short grass plains of the plateau and the ridged woodlands surrounding Lokisale Mountain. The *vitongoji* are critical elements of government structure in Maasailand (Igoe and Brockington 1999). There are three levels of conflict resolution available to village residents: the *mbalozi*, or 10-cell leader, a holdover position from the Tanzanian experiment with socialism[40], the subvillage leadership and the village leadership. While village leaders are village residents, they may preside over landscape changes that do not directly affect their livelihoods. Subvillage leaders (chairmen) are nearly always

[39] Loiborsoit does not have a title deed. There is some feeling in the village that the central government is deliberately ignoring their application because of the importance of the Plains in the ecology of TNP. Without a title deed it might be easier to force villagers abandon the region if land-use conflicts with conservation priorities.

[40] During socialism, an *mbalozi* was chosen in every neighborhood, 1 for every 10 people. They are the initial arbiters in all disputes.

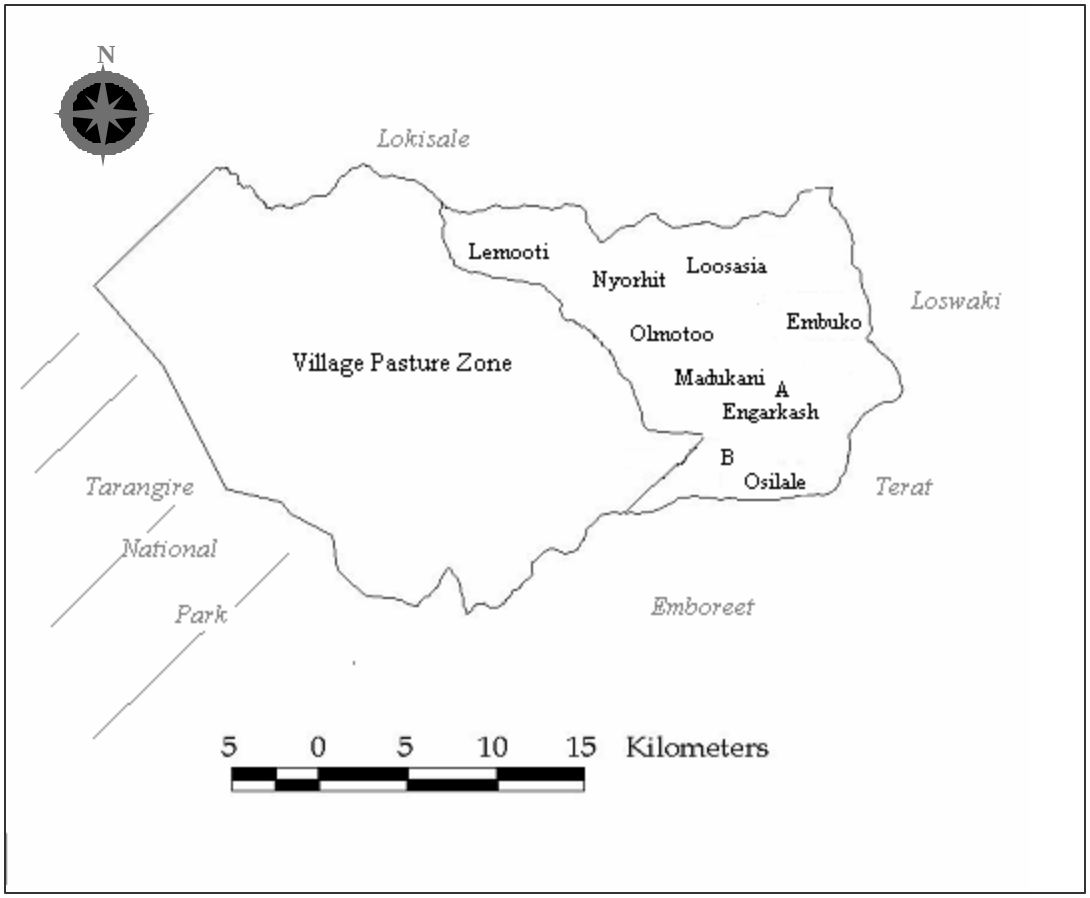



**Figure 3.1 Official internal boundaries of Loiborsoit A, adapted from Lama 1998.**
The eastern zone consists of 9 *vitongoji*, or subvillages, labeled as mixed use. I have chosen to not draw boundaries between the subvillages as they are socially, not spatially, defined (Lama 1998). The *vitongoji* landscapes are a matrix of allocated farm plots, both plowed and open, calf and smallstock pastures, and infrastructure. Most village infrastructure is located in the subvillage of Madukani, the most densely populated section of the village. To the west of the village is Tarangire National Park (TNP). To the east are Terat and Loswaki villages. To the north and south of Loiborsoit are the villages of Lokisale and Emboreet.

residents of the subvillage: changes in forage quality or accessibility impact them directly. When a conflict grows beyond the capacity of the *mbalozi* to negotiate, it is taken to the subvillage leadership. Land tenure is more directly related to the subvillage chairman: before land is allocated in the subvillage the local chairman and subvillage secretary both have to view the land and sign the agreement. In some instances the subvillage chairman moves during his tenure in office. This situation is nearly always

problematic: not only are they unavailable for conflict remediation in the case of land or resource disputes, but their reliance upon, and understanding of, localized pasture conditions is severed.

Modern pasture zones

Herders in Loiborsoit graze their animals through a matrix of allocated and unallocated lands, crop fields and commonly-held zoned pastures. In effect, the village pastures and traditional calf reserves are bounded pastures as described by Turner (1999), while the mixed use/agricultural zone is similar to the point-centered usufruct system, although in this case the points have more solid land rights attached to them. There are five different types of ownership zones used by villagers for grazing: village pastures, traditional calf reserves, personal pasture reserves, grazing land in the agricultural zone that hasn't been farmed yet and rangeland beyond the borders of the village (Table 3.1). I will describe each of these in turn, focusing on general biophysical characteristics and water availability.

1. *Zoned pastures:* Over half of the western portion of the village is zoned strictly for grazing. They begin just beyond a seasonal swamp running north to south across the village and extend across several ridges to the boundary of TNP. Temporary *bomas* can be built inside this zone but their occupation is limited to the dry season by the local government and the elders. The nearest ridge to the village is used throughout the year but access is limited as animals must return to the bomas at night. As the dry season progresses, herders then move westward to access pasture reserves. These drier pastures are infected with tsetse fly (*Glossina* sp). Tsetse flies are the vector for African

**Table 3.1 Ownership and rules of access for grazing resources used by Loiborsoit residents, 2001-3**

| Pasture type | User group | Rules | Water sources | Surveyed herding cycles (n=235) |
|---|---|---|---|---|
| Village pasture zone | All village members but effective use is limited by geography, particularly during the wet season<br><br>Decisions made by elders together with village government | All can graze there but none stay overnight during rains<br><br>Temporary bomas can be built for residence during dry season | Medium sized earthen dams (open access to village members)<br><br>Two boreholes. Water costs a nominal amount that is frequently beyond the reach of poorer village members | One day: 12.0 ± 3.0%<br><br>Both days: 22.3 ± 4.7% |
| Calf pastures<br><br>(*alalili*) | Subvillage members and others nearby<br><br>Decisions made by nearby elders | All local livestock may graze there during the rains<br><br>After the rains finish, adult animals cannot graze there. They may just travel through to reach water. | Village Boreholes<br><br>Wells dug by hand, access limited by clan or neighborhood<br><br>Standing water | One day: 5.3 ± 2.0%<br><br>Both days: 3.0 ± 2.8% |

| | | | | |
|---|---|---|---|---|
| Personal reserves | Members of the *boma* | As decided by *boma* head | Small homemade water catchments<br><br>Wells dug by hand<br><br>Other nearby water, i.e. standing water, villages water sources | One day: 12.3 ± 3.7%<br><br>Both days: 9.8 ± 2.6% [41] |
| Land not yet farmed but allocated. | Anyone living nearby | None. Usually used during non-water days. | Depends on location. | One day: 43.0 ± 3.6%<br><br>Both days: 39.2 ± 4.7% |
| Beyond village | Members of other villages. | Set up by host village<br><br>Loiborsoit usually uses only during rains. | Depends on location | One day: 2.1 ± 1.7%<br><br>Both days: 1.3 ± 0.9% |

[41] This proportion includes all grazing on personal property, including fields.

trypanosomiasis, an ungulate disease which can be both chronic and acute. In East Africa, the chronic form is the most common, weakening animals and decreasing milk production (Ford 1971). High tsetse levels render the drier pastures unsuitable for long-term grazing, yet they are extremely important within the herding system because the rains usually begin at the western reaches of the village and then move east. The ridge nearest TNP is not reached every year but is extremely important during the drier years. There are two main water sources in the eastern portion of the pasture zone, a small dam and a borehole. Both of these are located along the boundary between the mixed-use and pastures zones. Other small dams are available in the western portions of the pasture zone, built by hunting companies as wildlife watering holes. Both dams and the borehole are useable by all village residents but herders are charged for water at the borehole, based on herd size. Unlike traditional wells maintained by clans, modern water sources are available to anyone able to pay and sporadically maintained by the village government.

2. *Traditional calf reserves:* Calf reserves (*alalili*) surround water sources and are not grazed by healthy adult animals during the dry season in order to provide sick and young animals with access to forage close to water. There is also a smallstock *alalili* in one *kitongoji* encompassing a small seasonally flooded swamp rich in salt and the shrubs smallstock prefer. Decisions about these pastures are made during meetings each rainy season by elders living nearby. Before the rains the reserves are closed to healthy adult livestock. At the onset of the rains, elders meet to bless the cattle and determine when to open the reserve for grazing by healthy adult animals. Near the end of the rains they re-

establish reserve borders and declare the punishment for non-compliance. Usually the reserves are closed to healthy adults from April or May until October.

Most of the calf reserves in Loiborsoit predate the establishment of the village and have been in place since the 1950's. While there were fewer people in the area than presently, herds were already increasing[42] and local herders were concerned about loss of pasture near the traditional clan-owned wells. These wells were dug in the dry rivers that border several of the traditional *alalili*. Other calf reserves surround seasonal swamps in the plains and the main dam near the village pastures. While these water sources have been used all year long even before major land alienation began, the pressure on these pastures has increased greatly as the village has settled around the *alalili.* Although many calves and smallstock are now watered at the borehole in Madukani, these resources remain critical for calf survival as they provide forage closer to many bomas than the village pastures. *Alalili* are therefore protected from cultivation and potential encroachment by agricultural is swiftly opposed.

3. Personal alalili: All boma heads have set aside a portion of their allocation specifically to graze their young and/or sick animals. The size of these personal pastures depends on a variety of factors; proximity to communal alalili, number of animals, size and quality of allocation, and the amount of land devoted to farming. This last factor is frequently related to ethnicity—Arusha[43] agro-pastoralists devote more of their allocations to fields than Maasai do. For example, in the hilly *vitongoji* where most Arusha have their

[42] This increase in cattle may have been due to the creation of the Masai Reserve by the colonial government restricting all Maasai to a region centered on Simanjiro. This is also about the time of the eviction of Maasai from the Serengeti, many of whom ended up in Simanjiro (Igoe 2004).

[43] The Arusha, or Waarusha in Swahili, are an agropastoral Maa-speaking group with close cultural ties to the Kisongo Maasai

allocations, *alalili* are located along the bottom of the allocation. The strip of land left unplowed between fields and dry season river beds is considerably wider in Maasai plots than in Arusha plots.

4. *Uninhabited land:* For herders living in *vitongoji* far from village pasture zones, the most commonly used pastures are lands already allocated but not yet farmed or occupied. While most of the mixed land-use zone has been allocated, many families have not yet opened up their property for farming and habitation. Usually they are restricted by labor, distance to permanent water sources and schooling. Until these areas have easier access to water[44] and roads, many of these areas remain open. Anyone can use these lands, but in practice use is limited by geography and water, as is so often the case.

5. *Rangelands beyond village borders:* All of the above grazing areas were on land registered (although not titled) to Loiborsoit village. Some grazing is done on land outside Loiborsoit, for example goats are frequently grazed in the villages to the north or south of Loiborsoit, usually by individuals with family ties to those areas. These villages are known to have more saltlicks and better browse for smallstock, therefore smallstock are sent to their pastures, particularly in the early wet season.

***Modern grazing system***

Day-to-day pasture use

[44] During the field research portion of this study, a borehole was dug on the high plains by a photosafari company as partial payment for the use of village lands (see Chapter 2). The drilling of this borehole was a festive affair with local government leaders and roasted meat. Not only was the borehole exciting for those families whose women were walking many kilometers to fetch water, but villagers who had been allocated land there were also pleased by the development. Its worth noting that many of these individuals did not plan on living out there, but setting up workers to farm land while they lived in the village center. The company has not yet finished the borehole with a pump.

Herders in Loiborsoit use a modified version of the historical 2-day grazing system outlined in the first section. The first day is spent reaching water. Except for periods when there is recent rain, this usually means traveling to the small dam at the edge of the village pasture zone. Because not all permanent homesteads are close to the dam, it can also mean traveling to wells dug in seasonal riverbeds or very small local water holes built by a few bomas for local use. These small dams are most common on the plains. On the second day livestock are usually herded in a different direction in search of grazing, but this depends on location. For example, bomas located on the plains itself have access to large areas of open rangeland in the mixed-use zone while those near the village pasture zone may use it both days. Farther from the village pasture zone, herds frequently return to the same grazing area on both days. This is particularly common during the growing season, allowing herders to avoid conflict with crop fields.

Both modern village pasture zones and traditional pasture reserves are extremely important to the current grazing system. During periodic interviews about pasture use and agricultural conditions, I asked herders where the herds were grazing that day and the previous day. This covers the 2-day grazing cycle—one day the herds go for water, the second day they follow pasture, usually in a different direction. The proportion of these herding cycles utilizing the various pastures can be found in Table 3.1 (n=234). During the 16 months of fieldwork, 35.0% (±7.7%) of herding cycles included at least one day in the village pasture zone. About half of those cycles were spent entirely in the village pasture zone. About 7% of the herding cycles utilized the traditional calf and smallstock *alalili*, largely while traveling through the *alalili* to reach water and returning. Another

6.7% of smallstock (± 1.8%) were grazed in the *alalili*[45]. The low numbers for *alalili* use are probably a reflection of location and restricted access; only some of the subvillages have traditional pasture zones. Early in the allocation process, men were able to choose the area in which they wished to live. In a region with few water resources, proximity to permanent water becomes a major factor in choosing where to settle. Because local *alalili* were also located around permanent water sources, the earliest allocations are most likely to have local *alalili* around the oldest water sources. By the mid-1990s the only land in those areas available for allocation was given to family members already living in those subvillages. Because traditional calf areas are only found in the few *vitongoji* which are already nearest the main village pasture zone, herders in these *vitongoji* have disproportionate access to protected grazing land. This has important implications for long term sustainability; those far from protected pastures face a future with limited access to grazing resources.

On the other hand, nearly 80% of the of the village herding cycles used land outside of the village grazing zones, i.e., in the mixed-use zone. Grazing in the mixed-use zone is considerably more complicated than herding in the village pasture zone: unlike the official pasture zone, the mixed-use range is not made of explicit bounded entities. These ranges appear open, yet encompass overlapping ownership and usufruct rights. Most of the grazing outside of demarcated village pasture zones centered on allocated but as-yet unfarmed lands (56%). Inevitably these are the ranges most at risk of being plowed and lost to the grazing cycle. Many respondents expect decreased access to

[45] Smallstock are not usually herded in the 2-day grazing cycle used for cattle as their water requirements are far less stringent. These numbers are not shown in Table 3.1.

forage in the future and plan on decreasing herd size or moving the bulk of their animals to the large village pasture zone in the future.[46]

Mobility

As mentioned above, most of the grazing days occurred within the mixed land-use zone around the permanent bomas. Within the village, mobility is not yet a major problem, although there are concerns about the maintenance of cattle routes and grazing on the way to water sources. Cattle paths to water are created and maintained through discussion among *vitongoji* residents and conflicts between fields and paths are resolved in interminable meetings.[47] Due to long-standing agreements on priorities (cattle) and well-developed channels for conflict negotiation, no informants were concerned that the paths to water would be blocked. There is apprehension about the loss of grazing on the way to water. Cattle routes frequently overlap with roads and thus pass through some relatively densely farmed areas on the way to the main village dam. As these fields are expanded closer to the road, cattle are left with no where to graze on the way to water. This pushes herders to finish watering quickly in order to give the animals time to graze near the homestead before nightfall. Unfortunately, as dam usage increases so does the time spent waiting in line for water and a decreased time available for grazing on water days.

While there is no true dry season grazing reserve, compared with the pre-colonial era, Loiborsoit's village pasture zone is large enough to be used in a similar

[46] This may involve changing the village rules concerning which months cattle are permitted to sleep in the pasture zone.

[47] While Maasai in general enjoy politics (see Goldman 2006), Loiborsoit villagers have a reputation within Simanjiro for being particularly enamored of political expression.

manner. Despite high levels of tsetse incidence and few water sources, the western side of the village pastures, abutting TNP, becomes increasingly important as the dry months pass. The period of fieldwork followed a season where the short rains failed. When data collection commenced, rain had just begun to fall after nearly eight dry months and many of the herds were far into the village pasture zone, living in temporary bomas near the boundary of TNP. This is particularly true of herds whose home bomas were located near the edge of the village pasture zone. Herds were moved back to the home area as soon as possible,[48] and did not reach the far edges of the village again during the field season. While temporary camps were set up in the village pasture zone during the dry season, they remained relatively close the mixed-use zone. Increased intra-village movement might be more likely in a drier year. Seasons of high rainfall allow herders to avoid using the far reaches of the village pastures altogether; rainfall during 2002-3 was adequate, so little long distance travel was necessary. Another critical time for herds is at the very beginning of the rains, when sparse rainfall creates unevenly distributed patches of green forage. At this point herders may choose to send their livestock to nearby villages if grazing improves in those locations before Loiborsoit's pastures. Anecdotally, this appears to be particularly common for smallstock, whose requirements can be more easily met in the early rains by higher concentrations specific browse species found in the pasture zones of other villages.

[48] This actually took longer than expected as the rains were extremely heavy and made the black cotton valley soils impossible to pass. Wildlife had the same problem. Warriors reported a crush of wildebeest, zebra and livestock on the far side of these *enguseros*, trying to reach the wet season pastures on the Plains.

Conflict with cultivation

A more pressing reason to move herds from village lands is conflict with the growing local cultivation sector. The mixed-use zone of Loiborsoit is an evolving landscape, changing yearly due to shifts in food-production systems and therefore negotiation between crops and livestock is constant. As allocated land is settled and farmed, the open space available for herding around the boma is decreased. The increase in fields around the boma means not only is less land available for herding, but those herds still remaining near the boma are a threat to nearby crops, particularly when guarded by small children. Most Maasai would prefer to herd near the boma; not only does it decrease the opportunity for attack by predators, but it greatly increases the available labor pool. Small children and women involved in household tasks can still keep an eye on herds close to the boma. In the open plains, the distance a child can herd while still under the eye of an elder socializing outside the homestead is fairly far: in the wooded areas sight-distances are necessarily shorter and children cannot herd animals very far from home, thus increasing the potential contact between herd and field.

One *kitongoji* in particular has had to regulate grazing during the growing season to mitigate conflicts between cattle and fields. During *kitongoji* meetings to resolve one such incident, it was decided that all sub-village residents should move the bulk of their herds out of the sub-village during the growing season. Today, each boma keeps a milch herd at home with a few goats. The rest of the herds are sent north to the plain above *Lokisale* where there is an extensive *engusero*, a seasonally flooded short grass plain, in a largely unsettled area prized for its salty soils. The pasture area in the host village is much drier than Loiborsoit: standing water dries there earlier and then herds return to the

boma for the dry season. Maintaining access to important salt resources in the pasture zones of other villages is important and is the basis for much reciprocity with Loiborsoit lands. In this way accessibility to critical resources is preserved even in the face of changing land use.

## DISCUSSION

In general, the residents of Loiborsoit consider themselves to be blessed with good pastoral resources. Multiple water sources ensure that water is almost always available, even though some of the water is in areas heavily infested with tsetse. Even in bad years, very few sample bomas moved in search of pastures, knowing that other areas were likely far worse off than Loiborsoit. Indeed, during the drought just before my field work many respondents reported herders from other village searching for access to Loiborsoit pastures. However, in the last 2 decades there have been a series of poor years in which access to the grass within the park boundary might have allowed more herders to remain in a largely herding economy (Igoe 2004). These droughts, 1994/5, 2000/1, and 2005, have been extremely difficult for the pastoral economy and likely exacerbated by population growth and the increase in cultivation. Ironically, it is quite possible that heavy mortality of herds in 1994 due to the loss of traditional drought reserves in TNP forced herders to take up cultivation who might have otherwise continued in the pastoral economy. Weakened by drought and unable to reach historical grazing reserves in the Park, cattle were unable to survive a series of epizootics reaching Simanjiro.[49] This increased the uncertainty felt by Maasai herders, particularly the recently promoted Landis warrior age-set, and therefore the drive to diversify (Chapter 2).

[49] This was exacerbated in turn by the collapse of the government veterinary services due to economic recession. See Chapter 2.

The increase in cultivation and boundary creation means this is necessarily a grazing system in flux. It might be possible to imagine a scenario where herders move their animals to *vitongoji* on the plains to live in temporary bomas during the wet season, thus avoiding fields before harvest and saving personal *alalili* for the dry season. This is unlikely to happen due to the large numbers of wildebeest calving on the plains area and the concurrent fear of malignant catarrhal fever, a disease carried by wildebeest and transmitted to cattle through the nasal secretions of wildebeest calves. During the dry season, harvested fields will likely increase in importance. At the moment, fields are mainly grazed by smallstock and calves. In the more densely populated areas near the Madukani (shopping area), fields are already grazed heavily. This is a concern around the borehole in particular, as farmers do not feel they can deny others access to fields while they wait to water smaller animals. Whether the manure deposited can possibly make up for months of trampling and removal of crop residues is an interesting question.

***Common property regimes***

Turner (1999) critiques conceptual models of CPR regimes which depend upon clear rules of access and bounded commonly used resources. He points out that agropastoral communities are rarely fixed, either spatially or socially, and rules of access to communal resources are politically flexible. Non-equilibrium dynamics necessarily argue against boundaries and rigid access rights in favor of flexibility and mobility, yet modern political institutions do not map easily fit within that framework (Scoones 1995). I agree with Turner that the CPR conceptual models do not represent African pastoral grazing spaces and common areas. Traditionally the only spatial boundaries within Maasailand were between *olosho*, creating large territories with somewhat fluid

boundaries which have been contested frequently over the past century (Spencer 1993). Boundary making by the modern state across these traditional fluid boundaries has not been a positive move for the Maasai (Homewood 1995). The ability to opportunistically exploit ephemeral resource has become dependent upon negotiations with a range of new entities which may not have the necessary institutional flexibility or production systems so heavily dependent upon reciprocity networks.

By focusing on the village as an enclosed community of users during the zoning process, regional scale resource use was ignored. While Loiborsoit itself is relatively homogenous, its neighbors are not. Through the development and villagization process, many non-Maasai farmers have moved to the nearby villages with very different land-use agendas. It is unsurprising therefore, that neighboring villages with large non-Maasai contingents in village governments have chosen very different land use zones from Loiborsoit. Some of these are in direct conflict with the land uses chosen by Loiborsoit. One potential outcome is the loss of high-quality pastures in neighboring villages and thus will likely increase the size of the non-Loiborsoit herd using Loiborsoit's tsetse free pastures. Conflicts between ethnic groups and within Maasai economic pursuits has been common in other areas, particularly in Kenya, where privatization and subdivision of land began earlier and is more extensive (Campbell 1993, 2000). During the fieldwork an uneasy balance was maintained in the study area: pastoral-cultivator disagreements over land were frequent sources of discontent and concern among my informants.

It is worth noting very few families appear to move beyond the village during drought years as may have been the case in the past. Only two bomas reported having moved herds far away during the drought of 2000. In fact, by setting aside such a large

pasture zone, Loiborsoit is more likely to be the destination for other herders from other villages in dry seasons. This has happened during the most recent drought in 2005, thought to be the worst drought in Maasailand since 1960-1. The scarcity of forage in other Simanjiro villages pushed herders to request for pasture access in Loiborsoit: villagers have told me there were herds from all over the district grazing on designated village pasture zones during this period. Even in years with average rainfall, such as the field season, herds from Kisongo[50] were present on village lands, both in the pasture zone and the mixed use zone. During the study period there was much discussion in the village about whether and how to restrict these users from outside the village. As they were Maasai, no one wanted to refuse access to pasture in the event they might need reciprocal help in the future. Charging a minimal fee per herd to help with the costs of maintaining the dams was seen by some as a reasonable alternative, but difficult to enforce.

Given the potential for huge losses of grazing space as allocated land is cultivated both within and without village boundaries, it might be prudent for villagers to designate additional localized reserves modeled on the traditional *alalili*. Unfortunately, attempts to create calf reserves in subvillages farther from the already demarcated pastures have not been successful. In one *kitongoji*, a large farm grabbed by an outsider for speculation was returned to the village by his sons after his death. *Kitongoji* residents were interested in identifying the returned acreage as an official pasture reserve for the *kitongoji* but a corrupt leader sold it to a wealthy (non-Maasai) businessman. Once this became public, *kitongoji* members were furious. After reclaiming the land, the villagers chose to split it

[50] Kisongo is an area located west of Arusha. The city cannot spread farther in any other direction, due to dense settlement and farms, so is quickly developing the Kisongo plains. It is also drier than Loiborsoit.

into ten acre plots for people who were still searching for land rather than risk it being given away again.

The attempt to demarcate new sub-village calf *alalili*, even though it ultimately failed, points out a major alteration in the conceptualization of space and ecology brought about by boundary creation. Traditional pastures were based upon the location of accessible water. In contrast, the most commonly used grazing areas are now based upon fixed *boma* sites, which may or may not have easy access to water. Water availability was a factor in the creation of the mixed-use zone; subsequent water development by non-governmental organizations has created a system of have and have-nots with reference to easily accessible clean water for people and animals. Village members who received their land early in the allocation process certainly have the advantage over those either too young or uninterested in obtaining land allocations at that time; they are nearer the deepest wells and have the most desirable locations. Meanwhile, new allocations are filling in the 'holes' on the landscape, with little individual preference or socio-ecological rationale.

***Other stakeholders of the Commons***

Loiborsoit lies entirely within the system of Game Control Areas (GCAs) surrounding Tarangire National Park, which the village borders. Tanzanian GCAs are protected areas where cultivation and habitation are not prohibited, yet trophy hunting is not only allowed but encouraged. Hunting blocks have been allocated by the central government to hunting safari companies catering to the international market and are a source of considerable revenue to the national government. Therefore village members are not the only users of the village's commons, complicating governance, exclusion and

monitoring. The major issue here is that the different user groups, herders of cattle and 'herders' of wildlife have different goals for the use rangelands.[51] In a recent paper, Gereta et al. (2004) describe the GCAs surrounding TNP as being

> *"…heavily encroached by cattle, sheep and goats…This leads to a further reduction of grazing land for wildlife…"*

A Maasai would likely state the situation quite differently. In fact, the Maasai of Loiborsoit consistently question why the cattle of the government (i.e., wildebeest and other wildlife) are allowed to graze on Maasai lands while Maasai cattle are not allowed to graze inside TNP when the situation warrants it, as during the 2005 dry season. From the Maasai view, this directly contravenes one of the basic principles of East African pastoralism—reciprocity. Access to grazing is nearly always given when needed because of the uncertainty of the future ecological conditions. What keeps such easily negotiated access from turning into an open access system, is the underlying social structure which dictates that access is only requested when absolutely necessary (Igoe and Brockington 1999). It is this societal restriction which keeps the pastures managed, and it is this restriction that modern development most impacts by creating new rules, laws and owner groups which overlay traditional areas and compete for resources.

[51] Nor are either of these user groups completely homogenous. Just as village members can include people with differing commitment to cultivation or livestock, so the wildlife community has differences of opinion. For example, the conservation community has recently supported the development of photosafari agreements with village in order to create an economic reason to save wildlife habitat. Tanzanian law, however, prohibits wildlife viewing within hunting blocks in deference to the tourist hunting industry, even outside of hunting season.

***Environmental implications of the fragmented commons***

The restructuring of social boundaries through conservation and development impacts the robustness of the socio-ecological system. Models of grassland diversity suggest ranges which have evolved to handle heavy grazing pressures are remarkably resilient to changes in grazing intensity (Cingolari et al. 2001). Yet even though the rangeland within Loiborsoit might appear heterogeneous and ecologically representative of the former whole, recent models of the Serengeti-Mara ecosystem suggest that the loss of a savanna's functional heterogeneity may have hidden repercussions (Owen-Smith 2004). These models suggest if the Serengeti were to be fragmented the functional ecology of the savanna fragments would create dramatically different futures for the different wildlife populations. Animal populations in the less nutritious tall-grass savanna would be limited to low levels by the poor quality of the range. The high quality short grass plains could support increasing levels of herbivores during a series of good years due to the high quality of the forage, despite being drier than the tall-grass savanna. This comes at a price: because the short-grass plains have less predictable and lower rainfall (roughly analogous in species, grassland type and rainfall to the Simanjiro Plains), when the rains inevitably fail the models indicate there is not enough forage in reserve to support the large number of animals and the population crashes. In fact, models of plant nutrient levels and biomass designed by Voeten (1999) suggest this very scenario for Simanjiro. Through the creation of boundaries separating ecosystem units, the overall system becomes brittle and resilience is lost as resources are no longer accessible to either pastoral or wildlife. In time, this may lead to an entirely new ecosystem state, a process similar to that described by Holling and Gunderson (2002).

The creation of Tarangire National Park has separated dry season pastures within the park, including the critical drought reserve, from the high potential wet pastures in Simanjiro. Land use changes brought about in the past decades as a response to land tenure insecurity quite possibly could create a scenario similar to the one modeled by Owens-Smith for the Serengeti. Wildlife can still move around between the pastures, Maasai cattlemen cannot. In response, they have settled in the wet grasslands and the surrounding ridges as the plateau drops in the Rift Valley. It is possible that the bounded village pastures set aside during the zoning process will be a functional replicate for the drought season pastures lost within TNP and be able support the village herd during the periodic drought periods typical of semi-arid rangelands. In the Serengeti-Mara there is some evidence that the use of zoning can help wildlife persist beyond the park boundaries (Homewood et al. 2001), although some feel it is not enough to make up for land loss to cultivation and land use change (Lamprey and Reid 2004). In Simanjiro, even if the Loiborsoit grazing zone could support its own village herd, it is unlikely that the Loiborsoit grazing zone could support the herds of the entire Simanjiro plateau in particularly long or severe droughts.

The implications of these changes in land use for the ecological future of rangeland quality are complicated by research done on different ecological scales. On the one hand, a continental analysis of the maintenance of a tree-grass mosaic, the essential savanna character of African rangelands, places Simanjiro in a transition zone between 'stable' savannas, those which will always maintain conspicuous grass cover and 'unstable' wetter savannas which require fire and herbivory to maintain sufficient openings in forest canopy to support grasses (~650±174 mm mean annual precipitation)

(Sankaran et al. 2005). Simanjiro is on the drier end of that continuum, but anecdotal evidence suggests an increase in woody species across the plains region, an observation first made soon after the hardening of TNP boundaries (Kahurananga 1976, Peterson 1978). Still, Maasai informants believe this to be the result of increases in livestock pressure near the main areas of human habitation. Despite considerable apparent biomass during the dry season across the region, it is seen as less than earlier years. Periodic burning is necessary to maintain tender forage species, but decreases in dry biomass during the dry season mean fires are less hot than in the past and less able to burn off young saplings. Clearly the amount of biomass available at the end of an average growing season is a measure which should be monitored. Fire intervals currently do not seem too frequent. During the 2 years of field work, much of the plains were burnt. However this was largely the result of an escaped fire at the wrong season and before that fire many men were commenting on needing to burn some areas. Less burning took place in the savanna woodlands due to increases in farm density.[52] Kahurananga felt the region was already overgrazed at the time of the creation of Tarangire National Park, based on scanty coverage of *Themeda triandra*, or red oat grass, a highly palatable species preferred by wildlife (Mwalyosi 1991). In the 1950's, Simanjiro was referred to as a "sea of *Themeda*" (Peterson 1978). Kahurananga believed the loss of *Themeda* was the result of too little grass cover leading to insufficient burning. Currently *Themeda triandra* appears to have made a comeback, even with apparent changes in the fire regime: in order to examine the validity of this observation, grasses and herbs were surveyed during the study period and will be analyzed in the future.

[52] Some of these areas, including at least one calf reserve, were considerably encroached with annual grasses. Vegetation in the calf reserve was surveyed and will be analyzed to check this observation.

## CONCLUSION

Until the creation of the East African park system, pastoralists and wildlife shared the same grasslands. Their resource use was similar: opportunistic use of patchy resources in marginal environments, with a focus on mobility. Both wildlife and people moved out onto grasslands with no permanent water sources during the wet season and returned to well watered pastures after the rains. Modern conservation and development initiatives, some designed to protect wildlife and others to 'develop' local economies, reduce the overall persistence of dryland ecosystems in East Africa by restricting the scale of the landscape available to herbivores, particularly livestock. This situation, in return, sets the stage for further reductions in ecosystem resilience which can then hinder wild populations. This is true whether the goals are protecting part of an ecosystem or encouraging settlement and cultivation.

In this study of a local village pasture system, the new compressed pasture range has led to decreased mobility, despite the logic of increasing mobility and creating new alliances to survive in semi-arid environments. Tanzanian rural development has been based on the communal village model since Independence, a model not conducive to maintaining migrations of wildlife or herders. It is a model designed to protect land tenure and settle populations, not support mobility or biodiversity. Increased mobility and negotiations with new groups should have become more important with the compression of territory, in order to maintain access to the dynamic environmental conditions common in African drylands. Instead of encouraging new alliances, national land use policies undermined traditional tenure practices. This has increased the pressure to claim and protect lands (Ndagala 1997, Chapter 2) and decreased the ability of savanna ecosystems to support large numbers of herbivores. In Loiborsoit, former wet season

pastures now bear the brunt of grazing during most of the year and flexibility is largely limited to movements within the village, despite a grazing system that still depends partially on important resources outside of village boundaries. Non-Loiborsoit residents, largely from areas recently inundated by cultivating immigrants, are also dependent upon Loiborsoit resources as well. This could be a sign that mobility is increasingly uni-directional, not reciprocal, as Maasai at the edges of traditional ranges lose grazing areas to cultivation, both their own and that of outsiders.

Despite the drive to subdivide the land in order to claim it, Maasai still self-identify as pastoralists, or at the very least, herders-who-farm. The demand to allocate and plow the remaining commons has been strong, both from within and from outside the village. Village leaders currently appear to be firm in their resolve to protect the village pasture zones and resist requests for land allocations by younger men and non-village members. Certainly the 2005 drought has increased public support to hold onto pasture zones. Still, many village members are concerned about their ability to access pasture in the future, especially around permanent bomas. Others just say that in the future, "all the animals will have to go to *kiloriti,*" the section of the village pasture zone nearest to the village center. The ability for all Loiborsoit herders to use the village pasture zone is limited by the distances between the pastures and *bomas* in the eastern subvillages. As livestock are not allowed to sleep in the pasture zone during the rainy season, during this period livestock would need to be herded from the *boma* to the pasture daily. Not only would this be a difficult trek for many herders, but the travel routes would quickly be grazed down and animals would need to move farther into the pasture zone in search of forage—thus increasing the distance herds would need to travel each day. It is clear in

this analysis that while both demarcated pasture zones and the mixed-use zones contain important grazing for livestock, the open-rangeland in the mixed use zone is far more critical to the grazing cycles during the study period. It is also the land most vulnerable to conversion into crop-agriculture and lost from the grazing system. The *kitongoji* level would seem to be the operable unit for local, day-to-day land use planning, yet has shown itself to be vulnerable to the same pressures and conflicts over resources as the larger village.

Regional land-use planning could reconnect the fragmented pasture resources of Simanjiro Maasai. Supporting traditional cultural ties for pasture planning across the Maasai Steppe could both maintain access to critical resources and expand the effective areas of open space for grazing by all herbivores, wildlife and pastoral. Currently, agricultural zones in some villages lie directly within important resource areas and adjacent to Loiborsoit's pasture zones. Loss of pasture in those cultivation zones would both decrease access to livestock resources for Loiborsoit cattle and increase the pressure on Loiborsoit pastures by Maasai from other villages. Villages throughout Simanjiro already influence each other in reference to (non-) cooperation with wildlife officials—during tense periods after the 2000 drought some villages refused to work with conservation organizations and scientific researchers until they knew what how other villages were reacting to heightened tensions over grazing conflicts between wildlife, livestock and farming needs. Land tenure security and institutional support for these traditional ties would make more efficient use of ecosystem resources and support, rather than suppress, the resilience of this savanna ecosystem.


**Figure 4.1 A junior elder and worker with tractor**

# CHAPTER 4

## THE ECOLOGY OF THE NEW: EXPLORING AN EMERGING FARMING SYSTEM IN PASTORAL EAST AFRICA

### INTRODUCTION

Studies of human and cultural ecology (logically) focus on the study of "knowing", i.e., the expertise indigenous peoples have developed over time to survive in their particular environment. For researchers of pastoralism, this focus includes their extensive knowledge about livestock, how pastoralism as a production system works within the dynamics of the savanna ecosystem, and (more recently) how colonialism and globalization have led to the disintegration of many traditional pastoral systems (Little and Leslie 1999, McCabe 2003, Homewood and Rogers 1991, Turner 1999, Anderson 2002, and the past two chapters of this volume). Less frequently examined from a human ecology standpoint, but more often from a development or crisis intervention perspective, is the ecology of '*not*-knowing,'[53] of learning how to negotiate a new production system, or drastic environmental change. Just as the goals and expectations of a herder interested in meat production will be very different from herders focused on milk production, herders adopting cultivation may have a very different set of goals or management structure than cultivators integrating livestock into their farming system, or the traditional, intensive cultivators frequently studied by social scientists. These 'mixed farming systems,' where cultivation is tightly integrated with livestock production in

[53] Many thanks to Terry McCabe and Paul Leslie for bringing this to my attention.

order to maintain soil fertility, decrease the loss of nutrient flow off-farm, while simultaneously increasing productivity, are frequently viewed as the preferred smallholder system by development agencies. Wolmer (1997) notes that many emerging farming systems do not 'evolve' into mixed farming systems, for a variety of reasons. Maasai cultivation, developing from a livestock intensive production base, has the potential to become an integrated mixed-farming system but little research has been done on the mechanics of Maasai cultivation practices. Therefore, in this chapter I examine the human ecology of not-knowing, of shifting into a production system which has been intertwined with pastoralism for thousands of years, yet remains in many ways a foreign enterprise.

Specifically I am interested in examining how pastoralists react to the constraints on cultivation success. The risk avoidance methods used in cultivation will be very different than the risk avoidance techniques used successfully by herders to handle pastoral constraints. Mobility and flexibility, for example might still be useful but certainly not on the same time scale as livestock herding: cultivation requires a household to remain in one location at least through the growing season. Major cultivation constraints across the cultivation spectrum in semi-arid Africa include unreliable rainfall and poor soil fertility, but in sparsely inhabited savannas near protected areas wildlife predation will likely also play a role. Poor soil fertility and soil degradation in particular are widely viewed as major limitations on agricultural productivity in Africa (Sanchez 2002, Dejene et al. 1997, Tittonell et al. 2005). In Tanzania, a country where 86% of the population depends upon cultivation, soil degradation is compounded by land use conflicts—wildlife conservation and livestock production are increasingly facing the

expansion of rainfed agriculture into former pastures (National Bureau of Statistics Tanzania 2001). Among small-scale cultivators, within-farm variability can be very high: farmers differentiate both field intensity and use by emic (culturally defined) soil characteristics (Tittonell 2005). For Maasai pastoralists, who are culturally engaged in a production paradigm complementary yet largely inimical to cultivated agriculture, details like this might not be considered when developing their land use plans. There are many other possible constraints to cultivation which may take precedence in herder-farmer systems: maintenance of open cattle paths and reserve grazing for small animals, location of preferred wildlife habitat, distance from fields to home sites and the most efficient sites from which to guard crops. These constraints and decisions can have a major impact on the future agro-pastoral landscape of former rangelands. In doing so, they may influence the future sustainability of the farming-herding system as well as the resilience of the emerging socio-ecological system.

Simanjiro District is a semi-arid district in northern Tanzania utilized largely by pastoralists, but also by subsistence cultivators, gemstone miners and opportunistic commercial farmers (Lama 1998). It is viewed by the Tanzanian government as an important stretch of unfarmed arable land open for settlement (see Chapter 2). This view is partly based on the classification of the uplifted Plains region as sub-humid with good soils for farming (Reid et al. 2005: Figure 2.1), but seems mostly related to the lack of other open lands for cultivation between the semi-arid bush and crowded highlands in Northern Tanzania. Wildlife interests, on the other hand, have been quick to evince concern for the long term consequences of indigenous farming techniques on the soils (Nelson 2005, Mwalyosi 1992). These interests frequently claim that agro-pastoralists

from nearby areas destroy their own soil resources and then, when searching for fresh land to farm, transfer their poor husbandry skills with them into pastoral areas. This view repeats land degradation narratives popular in the world of international development and perpetuated by the conservation community (Swift 1996, Stocking 1992, Waller 1988, Brockington and Homewood 1996). By focusing only on the physical result of land management practices, these narratives ignore political interactions and unequal power relations that can lead to poor land management (Anderson 1984, Brockington and Homewood 1996). Pastoralism without cultivation has also frequently been singled out for disdain by western experts: African herders are regarded as obsessed with cattle, inevitably leading to overstocking, range degradation and, finally, soil erosion. It seems unavoidable that Maasai interest in cultivation would intensify the concerns of the wildlife sector regarding the ability of pastoralists to sustainably manage their landscape.

This study is based upon two years of fieldwork with the Maasai of Simanjiro. Because this time period is too short to investigate the long term evolution of agricultural skills, I have chosen to specifically examine the impact of cultivation constraints on household decisions regarding the organization of farming practices, in particular how cultivation and herding constraints are merging together in this new lifestyle. Several general hypotheses about Maasai cultivation and soil management skills were developed prior to fieldwork:

**H1:** The expansion pattern of cultivation across the landscape is shaped by constraints on cultivation arising from soil characteristics and wildlife. Specifically:

**$H_{1a}$:** Herder-farmers preferentially farm on the plains because soils will be richer in organic matter;

**$H_{1b}$:** Conversely, herder-farmers may avoid the plains due to heavy crop losses to migrating wildlife during the growing season. These choices are somewhat in opposition. If true, the decision to avoid wildlife may result in farming poorer soils and vice versa;

**$H_2$:** Within an allocation, land use decisions are based upon cultivation rather than pastoral constraints;

**H3:** Changes in soil quality are affecting expansion of cultivated fields and soil conservation practices.

**H3a:** Decreasing soil fertility is leading to expansion of fields to meet production needs.

**H3b:** Decreasing soil fertility is leading to an increase in soil conservation measures to improve and limit field size.

This chapter examines the arrangement, constraints and soil management of fields in an emerging farming system in Tanzanian Maasailand. I contend that Maasai base personal land-use decisions more on livestock production than cultivation success and it is precisely this aspect of Maasai cultivation which may seriously impact future equality and sustainability in the region, both socially and environmentally. Furthermore, while Maasai farmers are beginning to respond to soil degradation in a conservation manner, whole-hearted and effective action is limited by insecurity and capital constraints, especially labor.

## STUDY AREA AND METHODOLOGY

### *Geology and geography of Loiborsoit*

The village of Loiborsoit A is located on the edge of the Simanjiro plain, an ancient uplifted plateau of granitic-gneiss baserock located in the geologic Mozambique belt dating from 600 million years ago (Schulter 1997). To the north and west is the southern end of the Gregory Rift of the East African rift valley system; roughly 14 miles north of Loiborsoit administrative center the rocks and soils become volcanic. The village itself is split into 2 major zones: a large village pasture zone and another mixed-use zone split into 9 administrative units where permanent habitation and cultivation is permitted. The north-east portion of the village consists of steep marble ridges and thin soils, covered with *Azana garckeana-Lannea humilis-Acacia nilotica* woodland (as described by Peterson 1978). The north-west portion of the mixed farming zone has a more rolling topography covered with a similar broadleaf woodland type. The southern portion of the mixed-farming area is a flat to rolling plain dominated by *Themeda triandra-Panicum coloratum* grassland with small patches of *Acacia spp.* and *Commiphora schimperi* tree cover. That Simanjiro is unique in the area is easily observable in the early colonial maps: the uplifted Simanjiro plains are clearly marked from the vast semi-arid lowlands of north-central Maasailand (Hathout 1983). The plains are consistently referred to as medium potential in those same maps and a recent overview of east African rangelands refers to the area as arable (Reid et al. 2005), although it falls into ecological zone IV (semi-arid) according the Pratt, Greenway and Gwynne (1966), the reference still used as the standard in East African environmental studies (Reid et al. 2005).

Loiborsoit-A is one of four villages covering the plateau. All are largely pastoral, although the two eastern villages (including Loiborsoit) are rapidly becoming agro-pastoral. Of the two, Loiborsoit remains more resolutely Maasai in nature, resisting the onslaught of smallholder immigrants from more heavily populated highland areas in the Rift Valley. North of Loiborsoit is a series of solidly agro-pastoral villages and former government agricultural development villages. South of the Simanjiro Plains, the Maasai Steppe is populated by pastoralists, but to south-east, several foreign-owned commercial farms have been developed, removing important water points from pastoral (and wildlife) use. The development of cultivated agriculture in the Simanjiro region has been a concern for several decades (Borner 1985, Mwalyosi 1992a, b); Loiborsoit is the center of the Maasai agricultural transition on the plains of Simanjiro.

***Overall approach***

There are a number of ways to approach questions how cultivating landscapes evolve. One excellent way is through the use of Geographic Information Systems (GIS) to create and compare maps of landscape change over time. However, this method requires a detailed database of current mapped landscape elements developed from remotely sensed imagery and detailed ground truthing, historical landscape-level maps and a long enough time scale that the effects of constraints might actually be visible on the landscape. The agricultural landscape in Loiborsoit is still a very new phenomenon. While aerial photographs exist from the mid-1980s and the early 1990s, at those points in time very few people were actually farming. It would be difficult to determine if the growth in cultivation since those periods was impacted more by constraints or simply impacted by the pattern in which allocations were distributed. A current GIS of the

region being developed by researchers at the University of Florida[54] should help create a baseline landscape from which future trends may be predicted and modeled, but the predictions must be based on small-scale household level studies of constraints and attitudes. This is the primary contribution of the work presented here.

In a general analysis of the state of pastoralism in four villages within Simanjiro District,[55] researchers with the veterinary NGO VETAID, recorded a variety of constraints to success in both pastoralism and cultivation (Table 4.1) (Muir 1994). To address the variable impact of constraints across the landscape, I combined interviews and observation with quantitative data on measurable constraints: harvest loss to wildlife, rainfall gauges set up across the landscape, soil analysis, and smallholder-led farm mapping. In this way I was able to both cross-check exaggerated claims of crop loss and ensure my understanding of the constraints residents were facing. Rainfall, wildlife raiding and soil quality are expected to influence village level spatial patterns while pastoral needs, food security and capital are more likely to impact field size and location at the farm level. The responses to soil fertility loss and the implementation of soil conservation measures were examined both as a response to the stated constraints of herder-farmers and also as a major concern of non-governmental and governmental development organizations and wildlife concerns.

Information about farming practices and harvests were collected over a period of 20 months for 172 households in Loiborsoit (167 actually farming during the study

[54] This research is undertaken in conjunction with researchers from UNC-CH, University of Colorado and the University of Dar es Salaam (Institute of Resource Assessment).

[55] Loiborsoit was not among the surveyed villages, although Emboreet, Loiborsoit's southern neighbor was included. Loiborsoit used to be a subvillage of Emboreet and is still administratively in the same "Ward", roughly analogous to an American county.

**Table 4.1 Constraints to cultivation and pastoralism in Simanjiro[a] in the early 1990s (Muir 1994) and in Loiborsoit 2001-3 (current study)**

| Cultivation constraints | Pastoral constraints |
|---|---|
| **Muir 1994** | |
| Unreliable rainfall * | Disease and lack of veterinary drugs* |
| Mono-cropping | |
| Low production and declining yields | Poor water availability* |
| Poor seeds | |
| Cash/labor constraints*[b] | Concentration of livestock |
| Lack of tools and tractor tillage*[b] | |
| Poor crop husbandry skills | |
| No effective agricultural extension service | |
| Livestock and wildlife damage* | |
| **Additional constraints mentioned in Loiborsoit** | |
| Crop disease | Lack of grass resources / accessible pasture in dry season |
| Insect pests | No cattle dip resource for acaracide (ticks) |
| Soil erosion | Wildlife predation |
| *Uwezo* | Labor for herding |

Notes: Items marked by an asterick (*) were also mentioned constraints in the current study.
a Loiborsoit was not one of the sampled villages.
b Both cash/labor constraints and the lack of tools / tractors are included in the uwezo category but are not all of uwezo.

period). For this analysis, these interviews were collapsed into 153 farming groups, i.e., groups of households which have chosen to share agricultural duties and *uwezo*[56] (Table 4.2). These interviews included a series of questions about soil management, including fertilizer use, intercropping, the use of fallowing for soil fertility and soil erosion control. The household heads, and frequently their families, both described and walked their allocations with me; maps of field placement and configuration, grazing areas and living

[56] *Uwezo* is a Swahili word which loosely translates as "capital." It includes social capital, labor, funds, etc

space were drawn for 20 of the 79 *bomas*[57] (Figure 4.2). During interviews and field visits, I recorded soil management techniques used on each farm. A small subset of fields (11 farms) was mapped after owners indicated recent problems with wildlife raiding to record maize plant density and crop loss to wildlife were recorded. Of these, 8 farms (18 separate fields) were surveyed in randomly placed 5x5 meter plots for the average number of stalks with animal damage. My intent here was to verify informants' assertions. A more complete study mapping crop losses monthly for a year was beyond the scope of this study.[58] Because many ridgeland farms had already been harvested at the survey point, 6 of the 8 farms were on the plain. Four rain gauges were set up in *bomas* across the village and an attempt was made by *boma* residents to record rainfall.[59] In practice, only 2 of these rain gauges produced a full year of records.

***Soil data***

In order to span the environmental breadth of the farming areas in Loiborsoit (which should be indicative of the higher plateau of Simanjiro), the mixed-use area was divided into 3 broad vegetation zones; open plains, steep marble ridges covered with broadleaf/*Acacia* woodland, and a transitional zone of rolling tree savanna largely found at the interface between the other two habitat types (Table 4.2). These zones were delineated through personal experience with farm sites and discussions with Maasai

[57] While farms were walked with all informants, the mapped farms were chosen at random.

[58] This would no doubt provide a wealth of data. See Naughton-Treves (1998) for a study of crop-raiding near Kibale forest in Uganda, and Emerton and Mfunda (1999) for a study of crop-losses and economics west of Serengeti National Park.

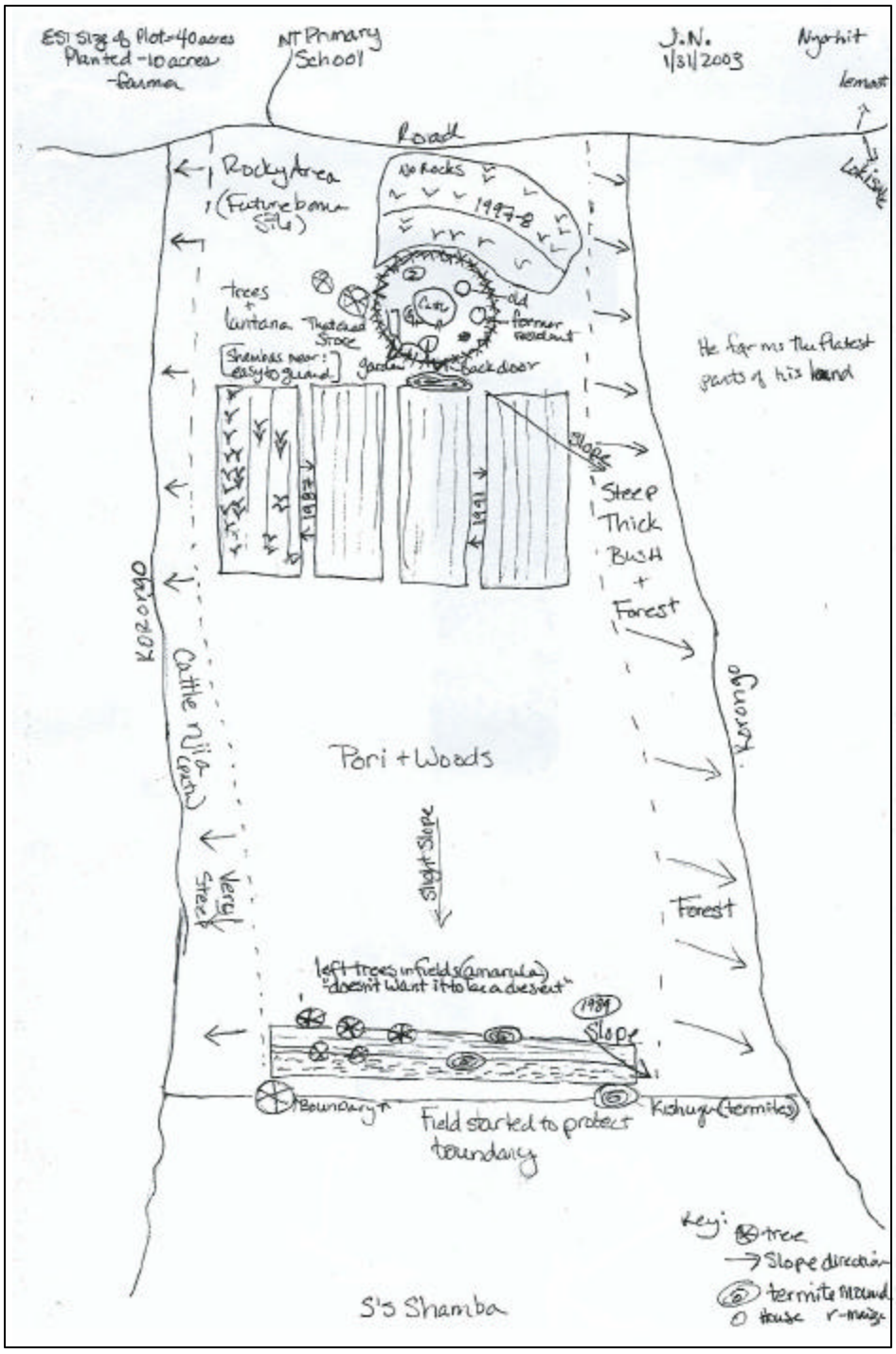
[59] These were in the house of my assistant's father, 2 of his sisters and a close friend, all who had finished primary school (i.e., literate—unusual in Loiborsoit). The friend frequently was gone or forgot to record rain and the younger sister was the youngest of many wives. When the first wife of her husband decided to use the pole for firewood, there was little she could do.

**Table 4.2 Sampling scheme for Loiborsoit A: a single-phase clustered sample of subvillages, bomas and households**

| | Grassy Plains with *Commiphora*/*Acacia* stands | | | | | Transitional wooded savanna | Wooded marble ridges | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Engarkash A** | **Engarkash B** | **Osilale** | **Olmotoo** | **Madukani** | **Lemooti** | **Nyorhit** | **Loosasia** | **Mbuko** | **Totals** |
| Boma sampled | 7 | 11 | 2 | 23 | 5 | 3 | 12 | 5 | 12 | 79 |
| Total households sampled | 17 | 27 | 3 | 64 | 6 | 5 | 25 | 7 | 19 | 191 |
| Average households per boma | 2.43 | 2.45 | 1.50 | 2.78 | 1.20 | 1.67 | 1.60 | 1.40 | 1.58 | 2.20 |
| Number of Farming Groups | 17 | 27 | 2 | 50 | 6 | 5 | 23 | 7 | 16 | 153 |
| % HH head Maasai | 76.5% | 100.0% | 100.0% | 92.2% | 83.3% | 100.0% | 87% | 85.7% | 73.7% | 88.8 |

Notes:
[a]A farming group is a collection of households who share both cultivating chores and harvests. Most farming groups contain only one household but the Olmotoo, Osilale and Mbuko samples had collective farming groups.

**Figure 4.2 Example of farm map in Nyorhit sub-village, drawn during informant interviews.**




Note: Maps were drawn with farmers, during a guided tour of the allocated farming plot. The maps are herder-farmer driven and reflect mostly the priorities of the boma head. This farmer is in the most cultivating subvillage, but is still leaving half of his allocation in pasture.

informants. While these regions were developed with soil qualities in mind (erosion/slope, leaf litter vs. grass cover), they also encompass the major environmental variables found in the mixed-use zone of Loiborsoit's zoning plan.

The purpose of the sampling procedure was two-fold. First, the sampling would provide a baseline picture of soil resources being farmed in Loiborsoit, especially differences across habitat types in the mixed farming zone. Secondly, I wanted to ascertain, if possible, what effect small-scale farming is having on the soil. Therefore attempts were made to find fields which had been farmed for 1-3 years, 4-7 years and over 13 years (see Appendix E). First attempts to find fields of the appropriate age and habitat class were drawn from the random sample of bomas used for the socio-economic portion of the study; all but one soil sample was obtained from this subset of village *bomas*. The management variables along the lower slopes were abandoned quickly: very few residents farmed this portion of the slope as this area was left open for smallstock and calf grazing reserves (see Chapter 3), or contained too much clay for easy plowing. Fields of all age classes and habitats were easily found along the upper slopes. During the analysis portion of the study a fourth variable was included to describe fields located on former cattle boma sites.

Samples of soil were collected across each field and then blended together. Roughly a kilogram of the mixed soil was then extracted and used for analysis. A description of each sampled field was recorded, including its size, the presence of termite mounds, observations of crop condition, weeds and trees species present and a description of field's management history. The samples were then taken to the Selian Agricultural Research Institute (SARI) in Arusha, and analyzed for nitrogen, available

phosphorous, organic carbon, cation exchange capacity and base saturation. SARI is the Tanzanian office of CIAT in Africa, the International Institute for Tropical Agriculture. The farmers who agreed to participate in the survey were given a character synopsis of their soil at a follow-up visit.

***Statistical analysis***

Demographic and agricultural production data obtained from surveys were analyzed in the open statistical package R (R Core Development Team 2006), using the "survey" package for analyzing data from complex surveys (Lumley 2006). This package uses the sample design, in this case a single-phase stratified cluster scheme, to determine overall population statistics while incorporating unequal sampling weights across strata. Median acreage and harvests were calculated as opposed to means because the data were highly skewed. Both the socio-economic and ecological data have log-normal sample distributions. An arithmetic mean does not provide a clear picture of the central tendency of this type of data because outliers—large herds or wealthy households, pull the mean away from the logical center of the data. The median is a more accurate snapshot of the data.[60]

Soil data were also examined in R (although not in "survey"). Because the structure of the sampling scheme necessitated finding and filling specific slope/field age/habitat combinations, some of which were unavailable, randomized sampling was impossible to obtain. Additionally, because there were nine different slope/habitat/age class combinations to sample, the number of samples per site combination was low,

[60] Geometric means are another possible way of describing the central tendency of log-normal distributions (see Limpert et al. 2001). Geometric means are nearly identical to medians, yet the confidence bounds for the median measures are less sensitive to large outliers.

ranging from 2-5 (median=3, 73 total samples). Variation within the soil sample units was high, suggesting a less homogenous geology than expected. Although small sample size and lack of randomization precluded analysis for significance, the data could still be explored for trends across site variables.

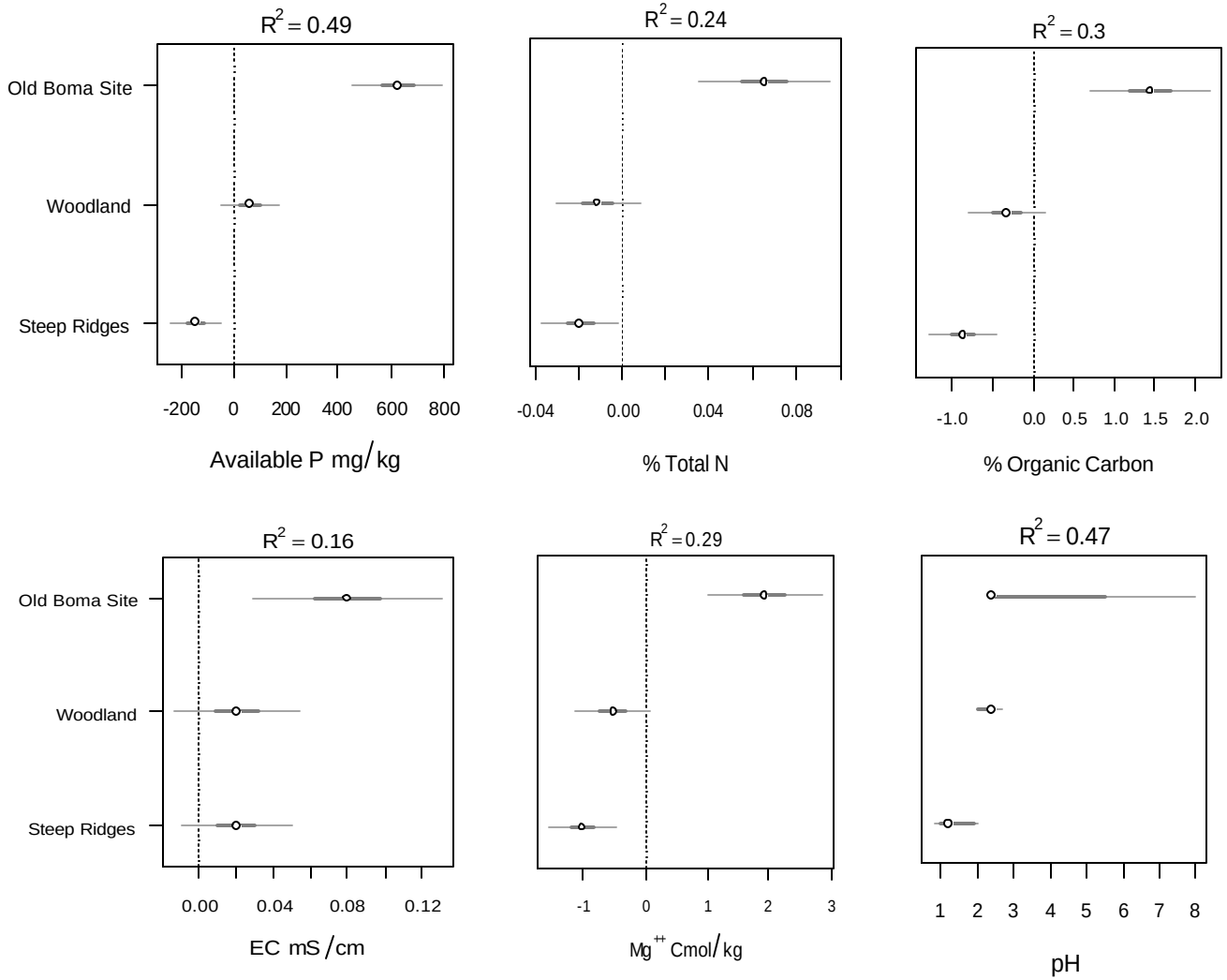
Multiple regression models were fitted to the data set in order to examine the general effect of habitat, slope and management (including presence of an old *boma* site) on soil characteristics. Using the rule of parsimony as a guide, the simplest explanatory models were chosen by comparing the Akaike Information Criterion (AIC) for different models of a variable's response to site conditions. The most important conditions for predicting soil variables were habitat type and the presence of old boma sites. The number of years a field was farmed had no apparent relation to soil variable response in this data set, possibly because the year groupings were chosen more on the basis of availability than known stages in nutrient depletion.

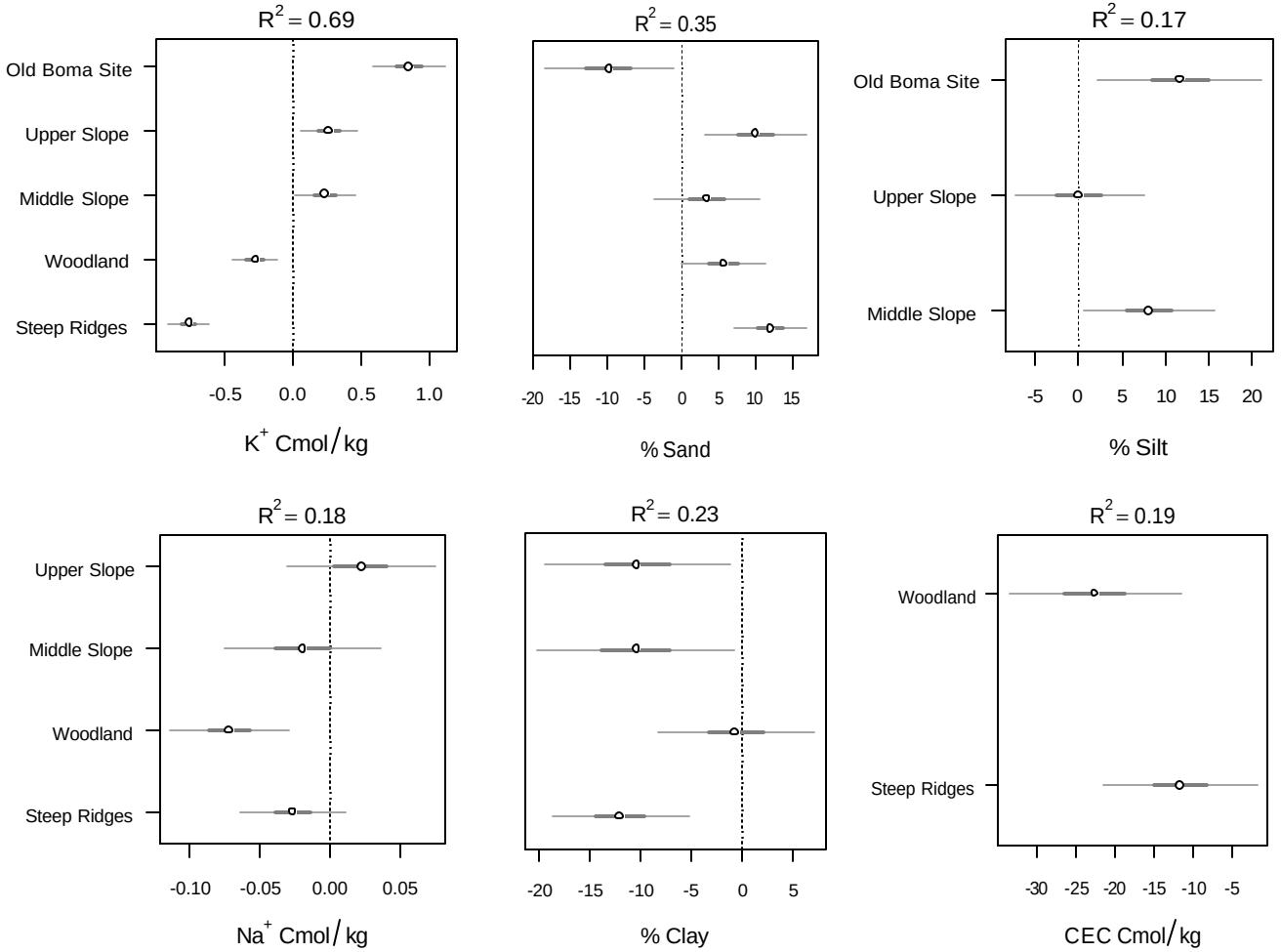
There were 14 soil variables tested and modeled, a multitude not uncommon in ecological and environmental studies. Fitting so many models raises both the concern of multiple comparisons and the greater logistical problem of how to summarize these results succinctly and elegantly. Gelman and Hill (2006) suggest replacing summary tables of individual regression coefficients with graphical displays. In particular, they propose a specific display referred to here as a probability smear graph. In a smear graph, parameter estimates are shown along with 50% and 95% confidence bounds for all the individual regressors in the model. In a smear graph, the effects of the regressors on the response are easily seen, their relative importance is accessed readily and their reliability is clearly evident (see Figure 4.3). In each of these graphs, both the modeled

response estimates of a nutrient to each site condition and confidence bounds are displayed in relation to the baseline conditions of plains habitat, lower slope and no old boma site present. As the graphs reveal, some predictor patterns are similar for several responses ($K^+$ and cation exchange capacity (CEC), $Mg^{++}$ and percent organic carbon (OC), etc.): others are dramatically different (e.g. sand). While these graphs are easy to examine individually for nutrient variations across slope, habitat and presence of old bomas, it is cumbersome to examine all 13 graphs for similarities in responses across the range of variables.

In order to distill the information in the graphs down to a single image, the graphical information was used to derive a response matrix relating the extent and direction of variables' difference from the baseline condition (Table 4.3). Each column represents a separate regression model and the cells contain the scores of individual regressors (site conditions) in the various models. Specific scoring rules can be found with the table. To summarize, the scores range from -2 to 2, with a score of 0 representing a regressor either absent or falling within the 50% confidence bound and a score of ±2 representing a regressor whose estimate and confidence bound fell entirely beyond the baseline condition. Principal component analysis (PCA) was then carried out on the entries in Table 4.3. PCA is a methodology which analyzes the total variance of a large data set with many variables in order to represent all the data as a smaller number of composite variables, called components and graphed as axes (McCune and Grace 95% of

**Figure 4.3 Probability smear graphs of soil variables as related to slope, habitat and former boma sites**






Notes: These probability smear graphs are based on Gelman and Hill (2006). The point estimate difference from the baseline condition, as determined by multiple regression modeling, is shown as the open circle, the 50% confidence bound is dark gray and the 95% confidence bound is light gray. The vertical line marks the baseline value as 0, i.e., the estimate for plains, lower slope, not a former *boma* site. The smears then show the extent of difference between the baseline value, scored as 0 and the confidence values.

**Table 4.3 Response variables and regressors derived from Figure 4.2**

| Site | K | P | Total.N | OC | EC | Mg | Na | CEC | Sand | Silt | Clay | Ca | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Old Boma | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | -2 | 2 | 0 | 0 | 2 |
| Upper Slope | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | -2 | 0 | 0 |
| Mid Slope | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | -2 | 0 | 0 |
| Woodland | -2 | 1 | -1 | -1 | -1 | -1 | -2 | -2 | 1 | 0 | 0 | 0 | 2 |
| Steep Ridges | -2 | -2 | -1 | -2 | -1 | -2 | -1 | -2 | 2 | 0 | -2 | 0 | 2 |

Notes: This table represents the responses of variables to 5 site conditions as determined by the individual regression models graphically displayed in Figure 4.3. These responses compare the response of variables against the estimate given for the baseline conditions of plains, lower slope, and no old boma site.



The scoring rules to convert Figure 4.3 into Table 4.3 are:

1. Any regressor absent from the AIC-best model for that response or which is present but whose 50% interval includes zero (the baseline) is given a score of “0” in that model.

2. Any regressor whose 95% interval (but not its 50% interval) includes zero is scored + / - 1, depending on the location of the point estimate when compared with the baseline conditions.

3. Any regressor for which neither its 95% nor the 50% interval includes 0 is scored +2 (if point estimate is positive) or -2 (if its point estimate is negative).

the variability in the data, indicating that the first two principle components accurately represent the relationships among the regression models. To visually examine these relationships, the principle component scores were used to produce a biplot of the data showing the location of other regressors (indicated as points) and the responses (indicated as arrows) in principle component space (Figure 4.4).

A note about measures:

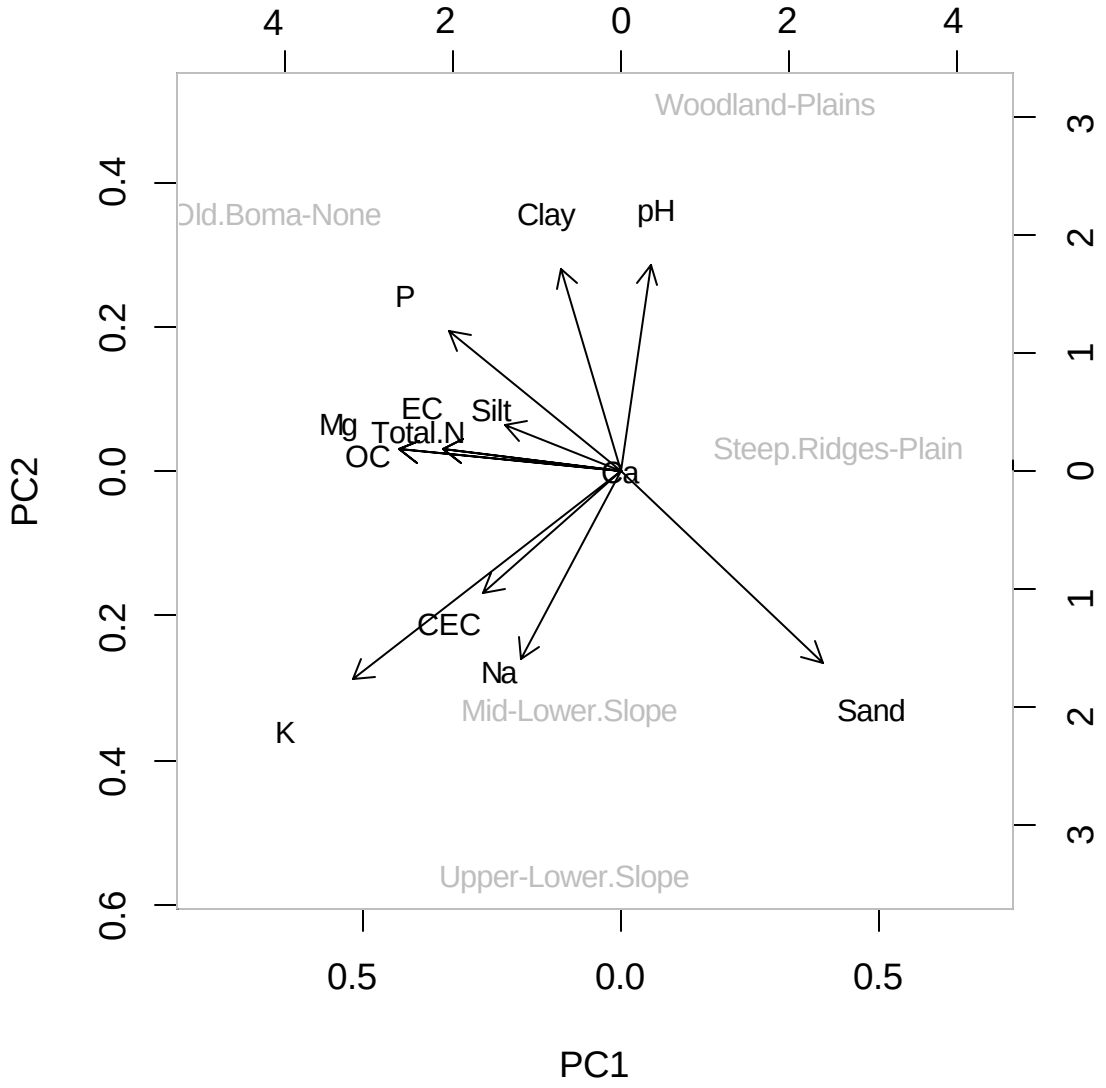
Harvests and area planted were given in local measures. Harvests were counted by *gunia*, a sack of roughly 90kg[61] maize, and *debe*, a bucket holding around 20 kg of maize, then converted into kilograms. Maize harvests are probably undercounted for poorer households in particular. Although all families enjoy fresh maize and therefore a certain portion of harvest never makes it into *gunia* at the end of the season, poorer households must eat more maize while fresh to make up for fewer milk resources during the growing season. Therefore the measure of maize harvest I collected is actually 'net' harvest—the amount each farming group has to survive the dry season. Villagers measure area in 'acres', calculated as 70 x 70 'steps[62].' Each step is assumed to be a meter, but of course every person's step measure is different. Most households plow their land with a tractor, at least initially. Tractor rental is by the acre,[63] the size of each field is negotiated between the step lengths of the tractor owner (who wants the size to be large) and the field owner (who wants the measure small to decrease cost). Between this

[61] I measured the weight of several *debe* to authenticate the weights.

[62] A traditional English acre is just over 4900 yards$^2$. Tanzania is a former British protectorate; therefore the English acre may be the source of the local calculation.

[63] Tractor rental during the field season was 12,000 to 15,000 Tanzanian shillings an 'acre', plus diesel. ($1US ~ 1000TSh)

**Figure 4.4 Principal component biplot of the relationships between soil nutrient responses to site characteristics as predicted by multivariate multiple regression modeling**




Notes: This principal component biplot illustrates the general features of the twelve regression equations as summarized in their probability smear graphs (Figure 4.3). Each arrow represents the difference between regressors (site conditions) and the baseline site condition (i.e., old boma site versus no old boma site in the top left quadrant). The center of the plot indicates no difference in the samples between old bomas and sites without old bomas, no differences between plains and not plains, and no differences in lower slope samples and samples from higher on the hillslope—in these samples on calcium(Ca), showed no response across treatments. In this graph the similar responses of some nutrients to site conditions (habitat, slope and/or presence of old boma sites) is easily seen by the confluence of their arrows. Sand has a much different response to habitat than all other soil characteristics, as is evidence by its arrow in the right lower quadrant. Probably most notable for this paper, cation exchange capacity and most major nutrients did not increase in the non-plains samples as compared with the plains. See text for complete explanation of the methodology.

negotiation, sizes are held relatively standard: a sub-sample of measured fields found the acres count reasonably accurate. Recorded acreage was then converted to hectares.

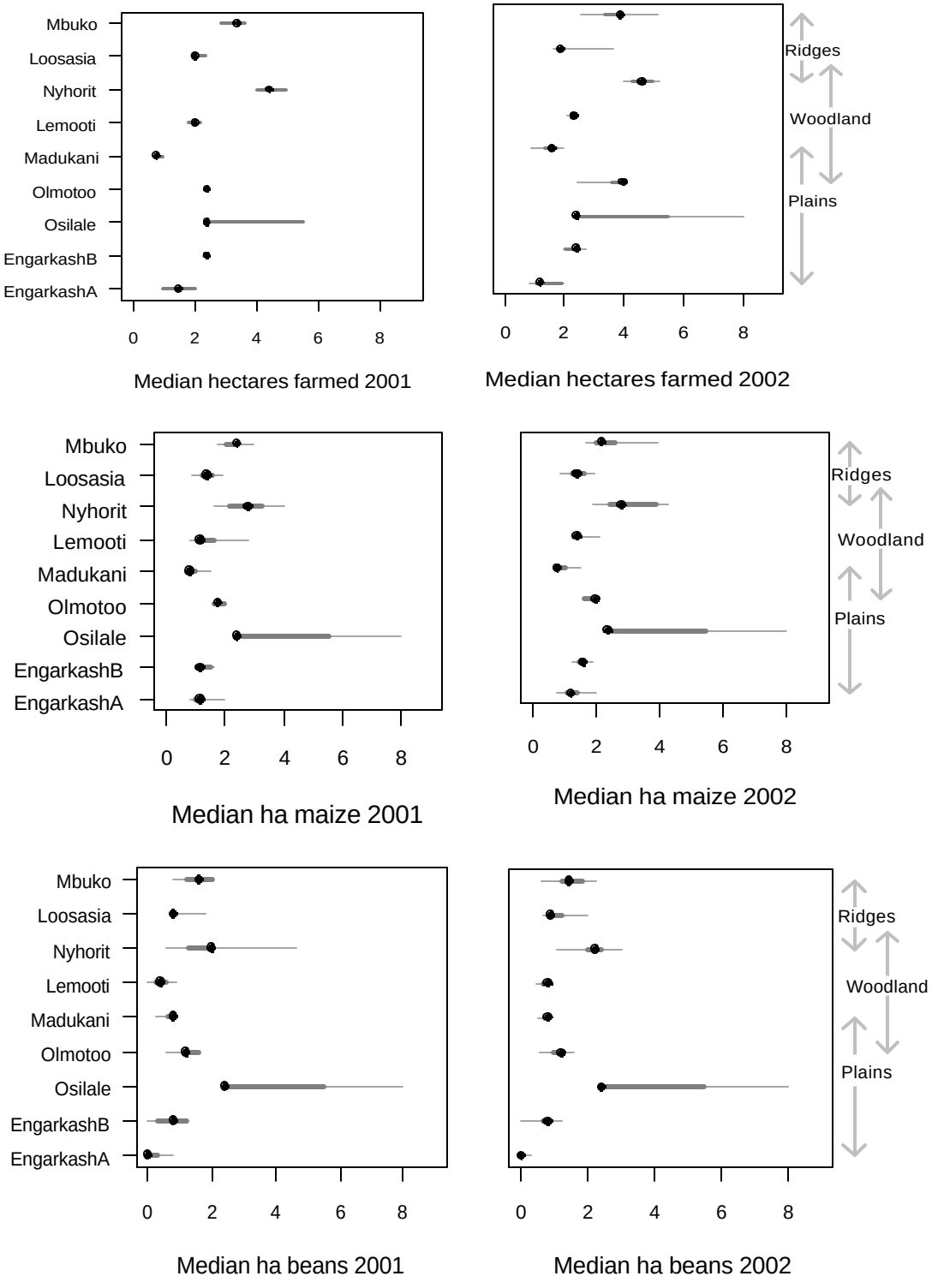
## CHARACTERISTICS AND CONSTRAINTS OF THE MAASAI HERDER-FARMER SYSTEM

In this section I begin with a brief overview of cultivation in the Loiborsoit herding-farming system. Then results of the various methodologies will be presented with respect to the stated hypotheses: first constraints which impact landscape level cultivation, then individual farm allocations and finally how herder-farmers are responding to soil fertility loss.

Seventy-five percent of farming groups in Loiborsoit farm far fewer than 5 (4.4, 6.0)[64] hectares (ha) and 50% (2.4, 3.9) of the farming groups farm less than 2.6 ha. Most of the larger fields are farmed by groups in the sub-villages of Nyorhit and Mbuko (Figure 4.5). While the Maasai and Arusha in the village farm primarily for subsistence maize production, in bountiful years extra grain is sold locally or in Arusha town in order to buy clothing or medicines, pay bridewealth or school fees, etc. Alternatively, dire need may drive a herder to sell maize he knows will be needed for food before the next rainy season. This mixture of consumption and market production within the same farm and with little year to year consistency, suggests smallholders in Loiborsoit fall into the mixed consumption agricultural theme described by Turner and Brush (1987, and Chapter 2). Beans are almost exclusively a market crop yet are similarly variable and equally small-scale. Bean production is less ubiquitous than maize: 71.8 % (± 6.2 %) of farming groups planted beans in 2001. There are a few farmers and farming groups in the village who are definitely aiming their production for the market. These herder-

[64] The numbers in the parentheses represent 95% confidence intervals for the given quantile.

**Figure 4.5 Agricultural summaries for 2002: hectares by farming group within subvillages.**




Note: Overall there was little difference in the acreage planted during the two years, although the confidence intervals shifted, indicating that farmer groups were shifting acreage around.

farmers generally enter a contract with one of several large agricultural firms in Arusha to grow specific beans to be used for food or for seed in Europe. Occasionally, wheat or sunflowers were grown and during one of the field study years several farmers experimented with growing canola.[65]

### *Landscape level constraints: rainfall, soil and wildlife*

In interviews and casual discussions, the herder-farmers of Loiborsoit identified unpredictable rainfall (11% of responses), crop-raiding wildlife (39%), insects and crop disease (17%), soil quality and slope (7%) as major constraints to cultivation success (Figure 4.6).[66] Less frequently reported, but clearly critical, is the *uwezo* of the household, the ability of the household to gather the labor and agricultural inputs to care for crops (3.5% of responses).[67] Each of these is discussed below. Constraints only mentioned a few times include losses to young boys and livestock, particularly donkeys.[68] A very few specifically stated there were no problems. Actual harvests of beans and maize per hectare are shown in Figure 4.5.

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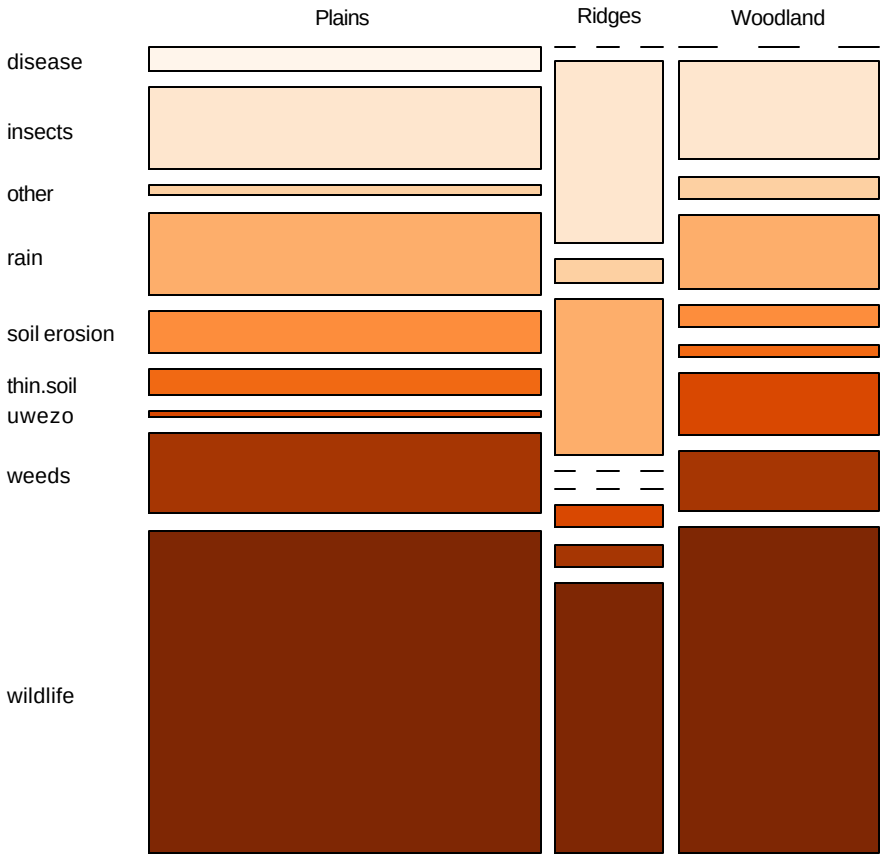
[65] During the final year of the field study many (but not all) of the larger farmers were downsizing their contract operations to focus on varieties of maize and beans with a strong local market. Reasons for this shift varied but frequently revolved around the perception (possibly true) that Maasai farmers were not receiving as high a price for their bean crop as non-Maasai, particularly expatriate, farmers. This disillusionment is striking: in the mid-1990s, Lama (1998) reports being frequently offered a position in various farming 'companies' run by local warriors for seed bean production. Creating these companies for seed-bean production was seen by many in the 1990s as *the* way to make money.

[66] Respondents were asked to name the constraints to agriculture. One hundred and nineteen farming-groups responded, most with two responses (196 total).

[67] It's hard to estimate how many times a day—every day—this topic came up. It was certainly a major preoccupation of herder-farmers in this village.

[68] These losses were not really considered losses as the maize eaten usually belonged to the household unit in some way. In cases where produce was consumed by members of other households, traditional restitution pathways were already in place.

**Figure 4.6 Mosaic plot of major constraints to cultivation success as offered by farming groups across habitat zones.**




Notes: Mosaic plots represent data from contingency tables as shaded tiles. Each tile proportionally represents a specific frequency from a contingency table (Friendly 1994).

This mosaic plot represents the top two major constraints as identified by respondents (n=196). 56% of responses came from farming groups on the plains, 15% from the steep wooded ridges and 29% from the transitional rolling woodlands described in Table 4.2.

The shades in this table are linked to a major cultivation constraint offered by interviewed farming groups. Dashed lines refer to no responses for that category from respondents in a particular habitat zone. For example, while disease was only mentioned by households living on the plains, far more residents of the ridges specifically mentioned insects than the other habitat zones.

Wildlife raiding is the number one constraint mentioned in all three habitat zones.

Responses from the plains and transitional woodlands mirror each other closely while the ridges appear to have a very different set of cultivation issues.

Rainfall

Spatial and temporal differences in rainfall amounts underlie farming success. It is so ubiquitous a constraint that it would frequently go unmentioned unless asked specifically.[69] Rainfall totals for Simanjiro are right at the lower boundary for maize cultivation. If it were consistent, or if it came during one season, the area could be productive agricultural land. Kahurananga reports a 600mm average rainfall averaged over 30 years at the Catholic Mission south of Loiborsoit (Kametz 1962, mimeograph cited by Kahurananga 1979). However, rainfall in Simanjiro, as in many savannas and the TME as a whole, is highly variable across time and space. Peterson (1978) reports an 11 year average of 529 mm, with individual years ranging from 334 to 759 mm in Loiborsoit village. Precipitation is also patchy: rain gauges set up across Loiborsoit village during the field period recorded a 150 mm a year difference between adjacent subvillages, a difference large enough to seriously impact harvests across the village.

There are theoretically 4 seasons in Loiborsoit; the long dry (May-October), short wet (November-December), short dry (January) and long wet (February or March through early May). In practice these seasons are inconsistent both in their onset and duration. The dry seasons are extremely dry: many months may pass with no rainfall at all. The short wet rains frequently fail, or come late and merge with the long rains. Because of this, most herder-farmers on the Simanjiro Plains only plant during the longer rainy season. Many local herder-farmers claim that good rainfall only falls once every six years. Some herder-farmers place an emphasis on finding soil which holds moisture, but this is hardly universal. While there are some labor-intensive technologies which can

[69] After being asked about rainfall, the informant would invariably look at me wondering how I came to ask such a silly question.

improve the soil's ability to retain rainfall, at this point in Maasai cultivating experience there is little to be done. One way of mitigating the risk of rain deficit (or surplus) is to diversify crops: as Maasai seldom plant anything beyond beans and maize, they diversify the types of maize and beans they plant. At least 4 different maize varieties are regularly planted by herder-farmers, each with different growth characteristics and taste.[70] By planting several maize varieties, herder-farmers hope to harvest at least some maize, no matter what the weather.

Soil characteristics

In general, the soils of Simanjiro have been variously described as red-brown, or dark red sandy clay loams (Kahurananga 1976, Peterson 1978), Seasonal swamps of black clay soils[71] which swell when wet and crack when dry drain water westward from the plains into the Tarangire River basin during the wet season. In the woodlands, small drainage lines and deep ravines drain rainfall northeast into the Pangani River. The ravines only hold water immediately after rainfall. The water tables are high here and deep wells are dug by the Maasai to water their animals during the dry season.

There are 3 general hillslope forms in Loiborsoit, which correspond to the general habitat classes used: rolling plains with occasional shallow wetlands, gently sloping savanna woodlands with small gullies at their base and long, steep marble ridges ending in ravines (*korongo*). There were few clear trends in soil quality along the slope gradient in this sample (Figures 4.3 and 4.4), although increases in the clay proportion and some decreases in K+, sand and silt traveling down slope were found among the samples. The

[70] These varieties are named for the hybrid seed they (usually) originated: Cargil, Katumani (a Kenyan semi-arid variety), Kilima, and Irangi. Kilima is the officially recommended variety, as it is a super-producer under good conditions. "Cargil" is preferred locally for its taste as *ugali*, a stiff maize "porridge".

[71] A vertosol known locally as black cotton soil.

soil texture changes are as one would expect, with the clay proportion greater at lower slopes and more sand at the top. However, multivariate modeling indicates that the presence of old boma sites and habitat type were the greatest overall predictors of soil characteristics, across the nutrient spectrum. In the principle component biplot (Figure 4.4), the relations between nutrient responses are shown. The arrows for organic carbon, magnesium cations, electrical conductivity and percent total nitrogen are essentially identical, illustrating their similar relationship with site conditions shown in their probability smear graphs. The steep ridged woodlands had a very strong effect on the total N, EC, $Mg^{++}$ and percent organic carbon grouping, and is plotted nearly at the opposite pole from this group of responses. Cation exchange capacity responded to site condition very similarly to K+, and they are grouped together in the same quadrant of principle component space with the other cations. Phosphorus levels were heavily influenced by the presence of old *boma* sites, as shown by its arrow on the graph. Overall, the plains and the ridges are distinctly different from each other in terms of soil nutrient levels. The plains samples were higher in nearly all tested nutrients than samples from the transitional woodland and steep ridged woodlands. Nitrogen was found to be low in all soil samples, although higher in old *boma* sites. In fact, locating a field in an old boma site is probably the best thing a herder-farmer can to do to improve his fields' basic soil fertility variables across the habitat spectrum.

Soil sampling also revealed a few volcanic intrusions in the woodland areas. These soils were grey, as compared to the mostly reddish-brown soils elsewhere in the village. The grey soils were exceptionally high in available phosphorus, electrical conductivity and higher cation exchange capacity, with comparatively high levels of

potassium, magnesium and calcium. Loiborsoit lies very near the southern extent of the Gregory Rift of the East African rift valley system that runs down from the Red Sea through Kenya, the same geological formation which produced mounts Kilimanjaro and Meru, both easily visible from Loiborsoit. The rich grey soil intrusions found in Loiborsoit are very similar to the geochemical composition of geological rift formations.

These soil differences impact field choice (when possible) in a variety of ways, but not all herder-farmers respond the same. Many living in the plains are pleased to have access to soil with good-water holding capacity but it makes tilling the land at the beginning of the season difficult. During the two planting seasons I observed, many plains farmers who had access to tractors had a difficult time actually getting the tractors into the fields because it was too muddy. Farmers in the hills were able to take advantage of the better drainage in the ridges and get seed into the ground early. The flip side, of course, is that when the rains tapered off, or a month without rain occurred midway through the wet season, their crops suffered. The evidence for H1a, regarding the willingness of herder-farmers to plow the grassy plains, is therefore inconclusive: while soils are richer in the plains than in the hills, the viability of a farm, and therefore the view of the farmer, may change depending on the season.

Destroyers of crops: wildlife, insects and weeds

While rainfall is the backdrop of harvest success and soil is its mediating factor, the most frequently mentioned constraint to cultivation is crop-raiding by wildlife. This occurs at all stages of crop production—birds descend on freshly planted fields to eat the seed, small antelope and tortoises eat seedlings, larger herbivores eat crop plants, hyena

and primates[72] harvest fresh maize. The amount actually taken varies considerably from location to location, boma to boma: maps of crop loss drawn close to harvest suggest anywhere from a few maize cobs to entire fields are lost. Loss depends on the raiding species (buffalo are harder to scare away than impala), the location of the field in relation to wildlife-harboring *korongo*,[73] and the amount of labor available for guarding. For most households, guarding was a task that occupied both day and night, particularly after flowering when the crops began to ripen. Women and the youngest children guard during the day as older children attend school, while warriors and elders sleep in the fields at night. On weekends schoolchildren take their turn at both herding and guarding. Given the extensive labor demands of livestock herding, this creates quite a bottleneck during the early dry season in particular, when rainwater is no longer available and more labor is needed to water livestock, yet the maize nearly ready to harvest. A field well-guarded will lose some grain to raiders but hold onto the majority. A field left unwatched while the household traveled for rituals, medical attention or cattle herding was lost. As one herder-farmer bluntly put it:

*"If you do not guard, why bother planting?"*

The intensity required of guards is nevertheless unequal across the village mixed-use zone. While I had hypothesized (H1b) that herder-farmers would avoid planting in the plains because they are major migration zones for large wild herbivores, plains animals are much easier to guard against than those animals living in the *korongos*.

[72] Baboons and vervet monkeys.

[73] A *korongo* is a steep dry ravine with an intermittent stream at its base. During the rainy season, water is often easily obtained in small surface pools. In the dry season, water is available by digging deep into the sand. Bushpigs, baboons and leopards are common *korongo* animals.

Maize hungry wildlife on the plains include porcupines, zebra and eland. Zebra and eland are easily chased away in the evening and do not require constant attention at night: as herd animals they instinctively stay in groups and shy away from possible predator shelters.[74] Porcupines cannot travel great distances and are frequently chased down and killed. *Korongo* animals, on the other hand, are able to retreat into the ravines and restage raids. As an indication of the intensity of crop raiding in the ridge and *korongo* portion of the village, at least two families in the sample were leaving *bomas* in that area for as-yet unfarmed allocations located on the plains specifically because they were tired of fighting baboons for their harvest. The perception of wildlife raiding is also critical to herder labor expense. During interviews, whenever a herder-farmer reported recent wildlife raiding I always requested to see the fields and eight farms were sampled for crop damage (18 separate fields, or blocks as defined by the herder-farmer). Overall, losses did not appear to be extensive. Maize cobs lost to wildlife ranged widely across fields, but on average 12% of the maize cobs were lost to wildlife in the sampled fields. Unguarded or insufficiently guarded fields had less success than the fields closely watched: one small household in the sample, whose one acre field was not surveyed, did lose everything to a herd of buffalo just before harvest. News like this spreads fast: it only takes one or two significant incidents before everyone is harvesting early.

In the early stages of the growing season, guarding is limited to watching for birds during the daytime. The real menaces at this point are insects. Cutworms, armyworms and other insects attack young plants long before flowering, especially beans. While most Maasai herder-farmers are aware of pesticides, few can afford to purchase chemical

[74] One Maasai farmer on the plains counted on lions hiding in patches of acacia trees to guard his maize.

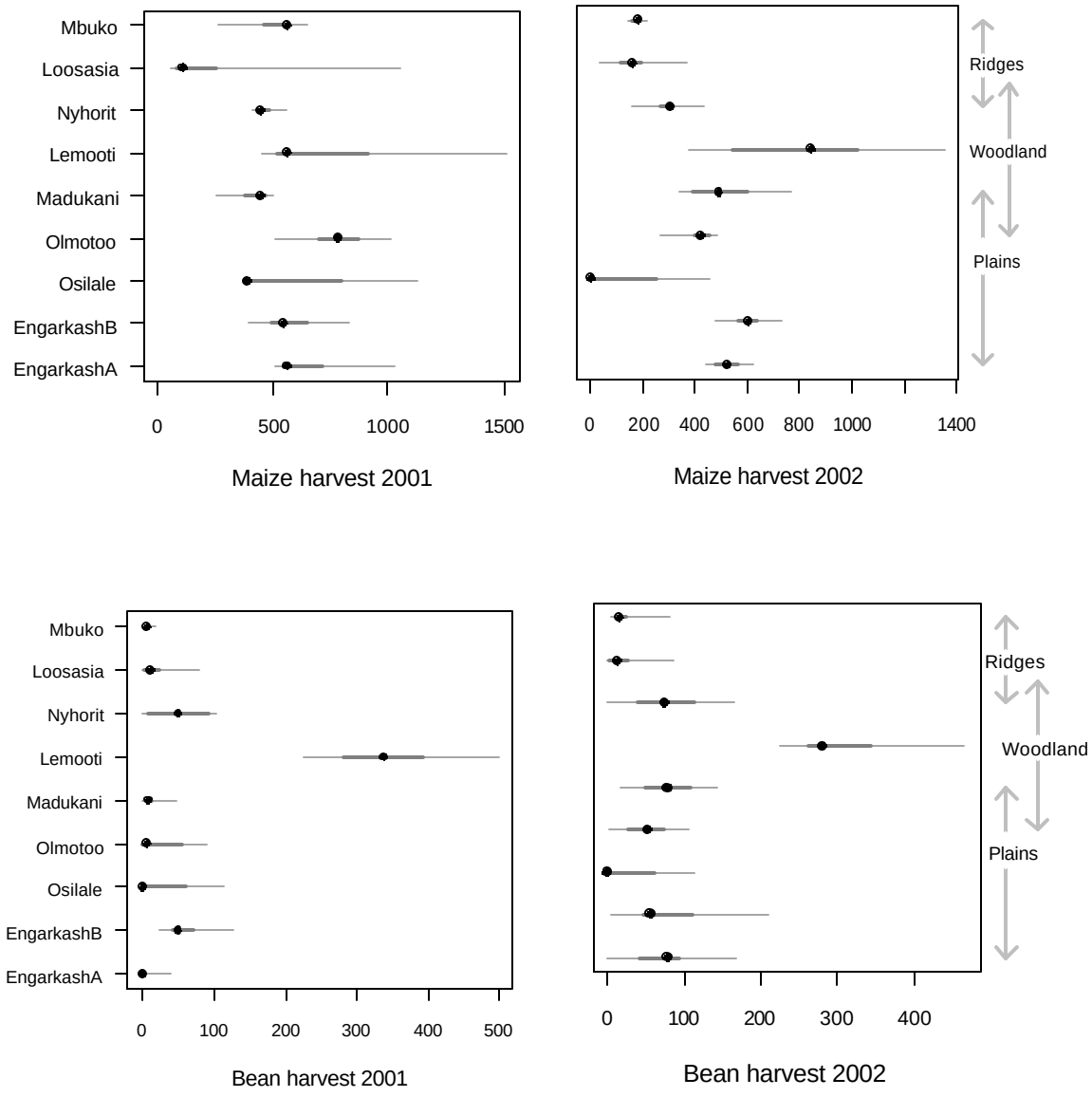
inputs. One solution is to weed early, in order to reduce the available vegetation, but that requires access to willing labor. Weeding is probably the least enjoyable task in cultivation and one Maasai are particularly reluctant to undertake. Whenever possible, non-Maasai day-laborers are hired for this purpose or to supplement household labor.

Evidence for the agricultural productivity differences between the ridges and the plains can be found in Figure 4.7. Maize harvests are much higher in the plains than the ridges. Maize harvests range from a median of 155 kg maize/ha (1.7 *gunia*) in Loosasia to 843 kg maize/ha (9.3 *gunia*) in Lemooti. [75] The more probable higher end can be found in Engarkash B, where farming groups claimed a harvest of 603 kg (6.7 *gunia*, median) per hectare. Insects are more equally spread across the village than wildlife raiding, as suggested by more standardized bean harvests across the subvillages (Figure 4.7). Whether these differences in harvest size are due to better soils, less wildlife predation or other factors is at this point unclear. During the study, informants suggested that there would be an increasing trend towards farming in the plains, particularly for maize.[76] Therefore the evidence for hypothesis H1 is inconclusive: while there is a trend towards increasing maize fields in the plains, the reason for this shift could either be improved soil or decreased wildlife predation. From a herder-farmer standpoint, plowing the plain might be a win-win situation.

[75] Lemooti only had a few *boma* and households and as it was farther to reach, I didn't know many of those households as well as the more central subvillages. I have serious doubts about the accuracy of the harvest data for Lemooti.

[76] Beans are preferentially planted in the transitional woodlands. When asked why, herder-farmers claim the "hewa", weather, is better for beans there.

**Figure 4.7 Agricultural summaries for 2002: median harvest per farming group in kilograms per hectare**




Notes: Maize harvests were overall higher in 2001 than in 2002 (750 vs. 560 kg/ha), although there was considerable variation across the village. Even discounting Lemooti, whose harvest totals are suspect, the plains had a much better year than the ridges. This difference might relate to differences in soil quality or wildlife pressure. Regarding the yearly variability, during the 2001 season, all the yearly rainfall came during the long rainy season, the short rains failed entirely. In 2002, while the yearly rainfall was exactly average, it covered 2 separate rainy periods separated by 5 months with no rain at all. This clarifies the difference between yearly averages and the amount of moisture actually available to crop agriculture in a given year. Bean harvests were lower in 2001, possibly because of the heavier rainfall. Many respondents complained that year had many insects.

***Constraints impacting household-level patterns***

Within-farm spatial configuration—boma placement, field size and location—appears to be influenced by several constraints. One is the amount of maize needed to make up for shortfalls in milk production as the number of cattle per person has declined. As a part of the survey, households were asked how much maize they actually needed to harvest in order to have food the entire dry season. The amount they needed per person was compared with the maize harvest per person in 2002. There was a significant shortfall in maize harvest that year, as determined through parametric testing ($p<.05$) using a gamma distribution as the best fit model. Permutation testing confirmed that result. Less than half (40-47%) of the farming groups who had complete data (n=79) harvested as much or more than needed to survive the dry season, leaving 53-60% of the farming groups to either reduce consumption below healthy levels or search for additional maize to meet the shortfall. This would suggest that need continues to drive some field expansion. However, the ability of a household or farming group to expand their fields is limited by *uwezo* and the pressure to protect pastoral resources near the *boma*.

Uwezo

*Uwezo*[77] can be loosely translated from Swahili as capital, both economic and social and encompasses the ability of a herder-farmer to mitigate the landscape level constraints discussed above. However, the ability of a farming-group to hire day-laborers to help with weeding or night-watchmen to assist with guarding is only part of the umbrella term "*uwezo.*" Most herder-farmers use tractors both for breaking in new

[77] Sometimes referred to as *uguvu (Swahili)*, or strength, due to the considerable political and economic capital necessary to gather resources for cultivation.

ground and the initial earth turning at the beginning of the rainy season. Ox plows and hand hoes are used for planting and weeding but tractors, while expensive, are preferred for the initial groundbreaking, usually every year. There are few tractors in the village and nearly everyone plows during the same month-long period. Without social access to a tractor owner it can be impossible to obtain one quickly when the rains begin. Frequently herder-farmers are left to gamble on an early rain (thus plowing and planting before the rains come in order to catch that first rainfall event) or wait until they know the rains are really there and risk planting late. Because of this, wealthy farmers and outsiders searching for access to land in Loiborsoit frequently must pay for land by plowing acres for the landholder. However, this leaves the land-holder vulnerable to the capriciousness of their '*watajiri*' (wealthy people) to plow their land. Very frequently, tractor owners will plow the most productive lands earliest after the rain, leaving the smaller and less desirable parcels to the last minute, forcing already poor households to plant late and jeopardize their harvests.

It takes considerable political and economic clout to gain a farming allocation and even more to start farming land once an official sub-lease has been obtained. Those household-heads who do not have an allocation (15.4 ± 4% of the village) must borrow from their boma head, form a farming-group with another household in the boma, or search for a neighbor or a friend to rent or borrow from. These farmers are particularly vulnerable because they cannot make decisions regarding their fields. Yet with 40.5 ± 5% of Loiborsoit farming groups borrowing fields, even those with allocations are regularly borrowing land. Their reasons are also considered problems with *uwezo*. For example, a family may lack the labor (warriors) to open new plots, a task which usually

involves creating a new boma and removing the household from the collective of herding labor available in the boma. There is seldom enough labor to support herding and farming tasks, particularly given the increase in young children attending school[78] and warriors leaving the village to work in the gemstone and tourism industries over the past decade.[79]

Pastoralism

The increasingly sedentary nature of the Maasai has led to a decrease in the ability of herders to find good grazing for their animals. A frequent complaint of herder-farmers, especially in the more densely occupied subvillages, was the lack of easily accessible pasture, particularly in the dry season (Table 4.2). The distance from the boma to water and calf reserves has also been hardened, as herders are less able to move their *boma* closer to important grazing resources (chapter 3). The rise in cultivation (and concomitant sedentary lifestyle) has decreased the ability of herders to move in search of pasture (Chapter 3) and my informants indicate they expect reduced grazing space around *bomas* in the future; therefore it is increasingly important to protect grazing space on a household's personal farming allocation. Every boma-owner has set aside a proportion of their allocation for cattle grazing, usually land at the lower reaches of the allocation so it is nearer *engesero* vegetation or water access. Field placement is determined by access to the boma, and boma placement is determined by a host of slope and ridge variables

[78] Over 55% ± 6% of households had children in primary school during the study period. Villagers frequently mentioned the increase in student enrollment compared with recent past and the 2006 graduating class was more than double the 2001 graduating class.

[79] Oddly, preliminary modeling suggested no link between warriors working in the tanzanite industry and an increase in field size. This might be that the measure was not precise enough. The greatest predictor of field size was the size of the farming group—suggesting *uwezo* is still more important than evident in the responses.

which are related to critical needs for livestock production. As hypothesized ($H_2$), the risk management techniques of pastoralism continue to shape farm organization, although mitigated by basic cultivation concerns, especially crop protection against wildlife.

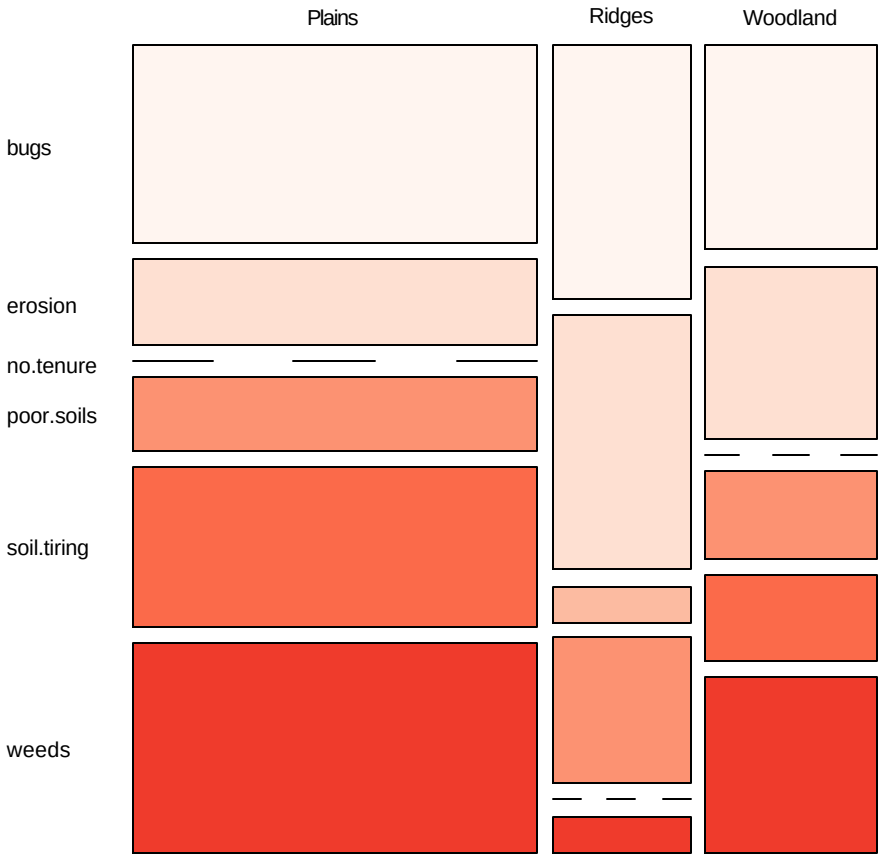
***Impact of soil degradation on management***

Finally, soil quality and soil erosion were stated as constraints to agricultural production by 7% of those who answered this question. Because of the long-term implications of soil health on sustainability of both cultivating and the grazing systems, it is worth describing their responses to this constraint in some depth. Household heads were asked their opinion of their soils for cultivation, with responses centered on soil problems (Figure 4.8). Of the 55 respondents who stated a clear opinion, the greatest number responded that physical soil erosion was an issue (11.1%), followed closely by a loss in soil fertility (9.2%) and a general impression of poor underlying soils for cultivation. Erosion was the issue brought up most in the deciduous woodlands of the village, both steep and rolling areas, followed by poor soils. In the plains, the major issue was the depletion of soil fertility, although poor soils, insects and erosion were also listed as concerns.

<u>Erosion:</u>

Many farms during the research period lost significant portions of their fields to heavy rainfalls during the early growing season and were forced to replant at least once. In an open-ended question about soil quality only 11% (Figure 4.8) of villagers reported erosion as a major concern while 21.5% claim it is not an issue: 75% of those

**Figure 4.8 Mosaic plot of erosion and fertility concerns expressed by farming groups in different habitats (the missing block is "decreased soil fertility"). N=75 responses**




Notes: In this mosaic plot, the individual tiles represent the proportional number of responses from each habitat reporting a specific soil problem (n=55). Usually only one soil problem was reported but if more were offered, they were included in this count. Also as in Figure 4.4, more responses came from the plains than the other two habitat zones, but this was expected as more households live on the plains than the other zones.

Weeds, tiring soils and insects are the major problems on the plains, where the oldest farms are situated. Many herder-farmers point to insects and weed infestation as a sign of exhausted soils. Soil erosion and insects are the major problems associated with the soils on the ridges. The ridge soils are less fertile than the plains, unless the herder-farmer has access to an old boma site on his allocation.

unconcerned about erosion farm in the plains, where slopes are minimal. Most fields in Loiborsoit are plowed along the contour, even in the plains, with nearly 42%[80] of respondents specifically mentioning plowing along the contours of the land in order to stop soil erosion (Table 4.3).[81] Usually two to three foot grass strips are left between fields to catch water and soil from flowing out of the field, but others add some combination of built walls, ditches or border planting to reduce soil loss. Whenever possible, farms in the steeper sub-villages place fields either near the crest of the ridges or in impressions along the hillside to decrease the risk of soil erosion. Two farms had already put in more formal terraces and several more, especially in the more heavily cultivated sub-village Nyorhit, were considering doing so in the near future.

Perhaps this is a rule that is only confirmed in the exception: only one farm among the sampled bomas was farmed against the contour. This boma was located near a seasonal swamp and the main corridor area for wildlife passing through the village pasture zone towards seasonal short grass pastures on the high plains. By planting against the contour, the senior elder was able to ensure the entire field could easily be seen by family members working in the boma and thus more easily guarded by his wives while keeping up with livestock and household activities during the daytime. In this case, the threat of wildlife predation was much greater than the loss of soil and crops to erosion because the farm was in a relatively flat location.

[80] The "survey" program extrapolates responses to population level statistics given the sampling design, in this case, just over 34%. However, this is based just on those who mentioned plowing against the slope.

[81] Some stated there had no problems with erosion because their land was relatively flat. Still, their fields were almost universally plowed along the contour.

**Table 4.3 Soil management techniques used by farming groups in Loiborsoit**

**a. Soil erosion control measures**

| *Action taken* | *% of farming groups* |
|---|---|
| Contours with grass strips | 33.6 |
| Terraces | 5.8 |
| Contours with ditches | 0.7 |
| Timely weeding | 0.5 |
| Border planting | 0.7 |
| Combination of the above | 1.3 |
| No control measure taken | 8.3 |
| Soil erosion is not a concern (flat fields) | 21.7 |
| Interested in adding soil conservation measures | 1.8 |

**b. Soil fertility improvement measures**

| *Action taken* | *% of farming groups* |
|---|---|
| *Manure use* | |
| Total number of farming groups using manure | 5.8 |
| Small area only | 1.3 |
| Bustani only | 0.7 |
| Crop residue | 0.6 |
| Passive manuring (old *boma* site, etc) | 5.3 |
| Does not manure | 69.0 |
| *Intercropping maize and beans* | |
| Farming groups who have ever intercropped | 40.4 |
| Always intercrop | 18.6 |
| Sometimes intercrops | 27.8 |
| Intercrops part of farm | 8.7 |
| Intercrops *bustani* only | 2.6 |
| Never intercrop | 35.0 |
| *Rotate maize and beans* | |
| Always rotates crops | 50.0 |
| Yearly | 19.0 |
| Every 2-3 years | 8.7 |
| Every 4-5 years | 1.3 |
| No schedule | 10.0 |
| Does not rotate crops | 29.4 |
| *Fallowing* | |
| Farming groups who have ever fallowed land | 10.5 |
| Intend to fallow but not yet | 15.9 |
| Never | 49.1 |

Notes: Percentages do not add to 100% because some respondents did not answer. Fallowing schedules are highly variable, but fields seldom rest more than a few years.

Wind erosion has not been a major discussion point among the farmers in the village, only one of 153 farming groups mentioned wind erosion. It might become a problem, particularly on the plains. Grazing by livestock on crop residues already leaves many fields bare of cover, particularly those in the village center near the borehole, a location which receives steady livestock traffic.[82] Many residents pay for the season's initial plowing by trading the use of several acres for plowing their acreage. This is one way agriculturalists from Arusha gain access to land in the village. While it seems like a good deal from the perspective of a household unable to rent a tractor, at least one of the renting farmers habitually cleans the fields of all crop residues after harvest, taking bean and maize residues to Arusha to feed zero grazed dairy cattle in the city. This practice effectively mines the soils of Loiborsoit of nutrients, permanently taking them away, as well as leaves the soils bare and without protection from erosion.

Soil fertility

Most, although not all, Maasai herder-farmers were aware that growing crops depletes the soil of necessary nutrients, a process referred to in Swahili as the soil becoming tired. Both grazing livestock and planting crops necessarily involve the removal of nutrients from one location, the pasture or field, and both redepositing and concentrating them elsewhere. This might be the cattle corral or on-farm latrines, or removed off-farm entirely through selling the harvest. Capturing this nutrient loss and reinvesting it in the fields is a major focus of sustainable farming systems worldwide. In

[82] One afternoon just before our first rainy season in the village, I was involved in negotiations with local builders regarding the new living hut we were constructing. As a storm approached from the east, a huge red wall of dust advanced towards us. The *wazungu*, westerners, watched it apprehensively but the builders just pulled their shuka over their heads, and turned their backs to the storm. The storm dissipated before raining and we were left with a pile of red dust covering everything. While this was not a Sahara-style dust storm, it was unnerving and many residents think the amount of dust is increasing. They point to villages in the north-east of Simanjiro where an influx of Arusha agro-pastoralists has transformed the landscape. The roads of some of these villages are said to be knee-deep in dust.

the soil analysis, the length of time a field had been planted was not found to be a major variable for any of the nutrient responses. Non-random and small sample size precludes the ability to draw landscape level inferences from that analysis. The lack of response may be because of different management and farming skills within the sampled landholders or possibly the chosen time series was not appropriate.

There are several mechanisms which can be used to redistribute or replenish soil fertility and structure, such as fallowing, either grazing animals on crop residues left in the fields or plowing crop residues into the fields before harvesting, manuring or the application of chemical fertilizers. All of these mechanisms are used by some Loiborsoit smallholders but none are widespread. Amending soil through the application of manure or chemical fertilizers is an extremely unusual practice among the farmers of Simanjiro. Only 6% of the villages' farming groups actively add manure to their fields for the purposes of fertility and no one used chemical fertilizers unless given to them by contract companies (Table 4.3). Despite the surplus of manure in the pastoral world, getting it from the boma and to the shamba, particularly the farther fields, involves considerable hard labor. Several men mentioned that they had been unable to convince their families to undertake the labor involved. The few fields which had had manure applied were clearly thriving in comparison with fields without manure application nearby. This was noted and discussed by neighbors yet because weeds also thrived in manure-rich plots, they were seldom emulated. Small kitchen gardens more frequently receive applications of manure because they are located inside the boma and therefore less labor is needed to get the readily available manure from the livestock corrals to the crops. However, very

few bomas actually have kitchen gardens.[83] More frequently, manure is passively applied to fields by grazing smallstock and calves on crop residues, by planting on top of old *boma* sites or by locating fields downhill from the *boma*. In this situation, when rains fall, nutrients from the cattle corral are washed into the upper fields.

Many herder-farmers told me they never intentionally allow a plowed field to rest: if they are unable to plant it for whatever reason, there is almost always someone interested in borrowing the plot for the season.[84] For these households the only time fields are left unplowed after being opened are times when the rains began but were so poor the family decided not to plant after all, or they did plant and the crops grew so poorly when the rains failed they were abandoned to concentrate labor on fields of higher promise. As the proportion of fields in the village nearing a decade or more under continuous cropping increases, more and more smallholders are either considering or have begun to fallow their fields. However, while many residents are beginning to consider fallowing land, there are others who do not consider their allocations large enough for new fields and *alalili* (pasture) for their animals. For these individuals, pasture is more important than crop production.

Some larger-scale farmers have found it difficult to fallow land due to the large number of individuals who were searching for land to farm. The village contains a sizeable population of non-Maa speaking people who have moved to Loiborsoit specifically to obtain access to land. While they are unlikely to ever receive more than a

[83] Kitchen gardens are often planted at the first sign of rain, even when the family chooses to wait until the rains are officially 'here' before planting the fields. Thus the early harvest from the kitchen gardens can be very important for household survival. The crops planted in the kitchen gardens largely mirror those planted in the field, maize (usually *katumani* maize, which is harvestable within 2 months of planting) and beans. There is some interest in pumpkins but residents found the seed difficult to obtain.

[84] There is often a price associated with the lending, either the cost of tractor rental for the owner's fields or a bag of maize per acre (not ha) borrowed.

market plot allocation, they want land to plant and thus press owners of larger fields to continue renting. One reason is that rents for the older fields appear to be less expensive than newer fields. Rents for already plowed land are usually one 90kg bag of grain per acre (less for beans). The oldest fields produce so much less per acre than new fields that the owners were forced to reduce the rent. One such owner, a relative of the earliest Maasai farmer in the district, plowed new land hoping to shift the usual renters from the old fields to the new one. The renters refused to shift however, when told that the rent would return to the normal 90 kg bag, despite being nearly assured of a larger harvest. Thus the owner was left in a bind: if she refused to rent the land to the poor families interested in it, she would lose social capital. If she continued to let the old land for reduced rates the fields would continue to degrade.

Crops which host nitrogen-fixing bacteria, mostly leguminous species, can be used to maintain or repair depleted soils in two ways, either by rotating beans throughout the farm and relieving the soil from nitrogen-hungry crops such as maize, or by intercropping the two simultaneously. After soil moisture, nitrogen is the next most limiting factor for cultivation. Of the two methods, crop rotation is the most widely practiced by Loiborsoit's herder-farmers (40%). Many reported rotating beans yearly, although as the acreage devoted to bean production is much less than that of maize, it must be assumed that only a small portion of a farming group's fields host nitrogen-fixing crops in any year and that only for one year at a time. Intercropping maize and beans together is a good way to integrate the nitrogen consuming and nitrogen producing parts of a farming system. Less than 20% of village herder-farmers always intercrop, although many have tried intercropping. Some farmers would like to intercrop more but

are unable to consistently obtain bean seed: others are aware that overall maize yields are less with intercropping due to less available acreage and feel that the loss in harvest is not worth the soil benefits at this time. The Waarusha, a Maa-speaking group of agro-pastoralists, nearly always intercrop maize and beans but that is certainly not enough to engender Maasai support.

With respect to the third hypothesis ($H_3$), it appears that the loss of soil fertility in the future may lead to increased field size when and where *uwezo* permits, as herder-farmers are beginning to allow fields to lie fallow. Most herder-farmers at this time are not fallowing however, as they do not have the capital to expand or are unwilling to plow valuable pasture. Instead, they search for land from other local residents who were not able to farm in a given season, or are in a location without heavy wildlife raiding.

**DISCUSSION**

*"Kumbe, ni ng'ombe ndani ya ardhi!"*[85]
--Maasai elder recalling his early appreciation for the agropastoral lifestyle of cultivating Waarusha neighbors.

Maasai are still learning how to integrate cultivation with traditional livestock keeping. Even accounting for maize eaten during the growing season, the average net maize yields in Loiborsoit (645 kg/ha average from 2001 and 2000) are considerably lower than the Tanzanian average (1090 kg/ha, FAO 2002), although on par with those of some Maa-speaking agro-pastoralists (Little 1985). While farming in Loiborsoit is relatively low in returns, it is an activity crucial to the survival of many village families. The Maasai elder quoted above may be referring to the ability of cultivators to purchase livestock or veterinary drugs with money from the sale of bean harvests or to a herder-

[85] Imagine, there are cattle within the earth!

farmers access to food without selling livestock—in either case, protecting the livestock per capita balance critical for a pastoralist to remain even partially in the pastoral sector.

Herder-farmers identified several constraints to cultivation success, including rainfall, *uwezo*, soil quality and management and raiding by wildlife. Little can be done about rainfall, the primary constraint and one which has kept cultivation off of the plains up to this point. *Uwezo*, the ability of a farming group to gather resources for cultivation, particularly labor and land, impacts the ability of the farming group to cushion the impact of soil quality and labor constraints. For example, given that pastoral production tasks usually supersede those of cultivation, having sufficient warriors to share cultivation and herding tasks makes it much simpler to pass through labor bottlenecks. It is advantageous to stay within a multiple household boma as a way to ensure herding duties are not shirked: however the need to hold one's allocation by living on it directly contradicts this advantage. Having a close relationship with a tractor owner, either through family or age-set connections, also makes it much simpler to cultivate during the optimum time frame at the beginning of the rains.

One constraint seldom mentioned, yet relatively easy to manage, is seed quality. Even though hybrid maize seed is available in Tanzania for dryland agriculture, very few residents purchase new maize, preferring to save maize seed from the year before[86] or purchase it locally from individuals who claim the seed has only been planted one season since it was purchased new. Many are too poor to buy seed with any claim of being 'fresh,' and many others are completely unaware maize production is reduced as seed is

[86] One of the early white settlers in the area taught many Makaa elders to 'grade' their maize seed. They save the center portion of the cob to use as seed but use the kernels on the ends for maize meal.

reused. In fact, many found it difficult to obtain seed at all, particularly after a bad season when seed saved for planting instead is consumed to survive.

***Impact of production constraints on village level patterns ($H_{1a}$)***

As hypothesized, production constraints do impact the behavior of herder-farmers in Loiborsoit, both across the landscape and within their own farming allocations. Crop raiding by ravine dwelling wildlife had actually pushed some farming groups to either abandon fields in the ridged woodlands or shift resources between the plains and the woodlands to minimize risk, thus disproving $H_{1b}$. The woodlands, particularly the ridged woodlands, are overwhelmingly preferred for bean production, while maize is viewed as the optimal crop for the plains. This is related to the higher water retention capability of the heavier savanna soils (thus supporting H1a for maize), but the lack of aggressive wildlife on the plains might be more important in this decision. However the ability of a household to access land on the plain is related to the land allocation process.

Land allocation in the village is a complicated and heavily debated process (see Chapter 3). Very few village members were able to choose the land they were allocated for farming; those that were, were among the first wave of allocations handed out from 1988-89. Historically, Maasai were transhumant herders, who moved seasonally between wet and dry season grazing zones (Chapter 4, Homewood and Rodgers 1991, Igoe and Brockington 1999). In average years, their movements were relatively fixed and families used the same *bomas* for several years. When a new boma was necessary, due to manure buildup or tragedy, the new *boma* relocated nearby. In this way, specific areas were known to be places of certain elders (Mara Goldman, personal communication 4/06). During the first round of allocations when Loiborsoit was created, these elders or their

warriors chose land in the areas they knew best, where they had lived and herded before. For example, one elder, a traditional cultural leader of the *Seuri* age-set, claimed an area of personal importance: the boma site where he started his own family and where the *Seuri Oln'gesher* ceremony was held, the ceremony during which the warrior age-set graduated to become elders.[87] Some of the politicized young men who gained allocations at this time specifically looked to gain land non-Maasai considered to be prime agricultural land, land in the sub-village of Nyorhit or just below there. These areas are not too steep for easy mechanization and have easy access to both Loiborsoit market and the more agricultural markets to the north. Because there had only been a few large *bomas* in the period before cultivation became widespread, there were relatively few men who were able to return to such 'traditional' sites. Later waves of allocation generally tried to keep members of a subvillage within the subvillage, as *bomas* were split and young men angled to stay near their families. By 2002, most land had been allocated in the mixed farming area and new farm allocations are now being squeezed between earlier allocations or pushed to the margins of the village. These new allocations are located in remote areas where water restrictions have limited their use.

The result of this allocation pattern on soil resources is that farm areas allocated soon after Loiborsoit gained the right to allocate land have a much higher concentration of old *boma* sites, and therefore potentially richer soil resources, then many new farms or those at the edges of the villages. Even in those areas of the village which were settled early, differences can arise due to location along the slope of the ridge, for example.

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[87] There are three different parts to this ceremony: one is held at a traditional location between Mounts Kilimanjaro and Meru for all Kisongo Maasai and Arusha in Tanzania while the other two are smaller and held in local neighborhoods or (currently) villages (see Goldman 2006). This was a local ceremony.

Most herders prefer their *bomas* to be located near the top of the ridge (see next section). Originally, allocations in the sloped areas were given from the top of the slope to the *korongo*, or dry river bed, at the bottom. This meant all herders had access to the higher reaches of the ridge, which were preferred for *bomas*. In some locations it was realized that this allocation pattern led to unequal parcel sizes as slopes varied in length. With petitions for allocations increasing, the land committee found it necessary to subdivide slopes horizontally as well as vertically. Livestock grazing redistributes nutrients across the landscape to focus on livestock camps and homesteads (Turner 1998, Augustine 2003). The redistribution of phosphorus and nitrogen can be surprisingly persistent over time, as seen in Figure 4.3: many of the oldest fields are old *boma* sites. This suggests the upper portions of the soil catena may have a wider range of edaphic factors because the propensity of herders to place *bomas* in the upper proportions of the catena, a contention supported by both ethnographic and physical data. Herders who received the upper portions are both closer to the road and may be more likely to gain access to former *boma* sites or other rich soils in their allocations. Thus, early allocations based on cultural characteristics reflecting the transhumant-pastoral past has led to serious differences in the soil quality of allocations for the current sedentary herder-farmer.

***Impact of production constraints on within-farm organization ($H_2$)***

Within a farming allocation, farm organization is arranged around accessibility to the *boma*. As mentioned above, *bomas* are nearly always located near the crest of ridges and swells. There are two possible reasons for locating *bomas* at the top of ridges. First, along the heavily dissected and ridged portion of the village, the roads follow the ridgeline, making fields and *bomas* at the top more accessible to increasing vehicle

traffic. However, some of the roads in the ridged subvillages were created only recently and are less likely to impact earlier fields. Building near the crests can also facilitate pastoral goals. Western and Dunne (1979) found Maasai in southern Kenya, near Mt. Kilimanjaro in Kenya, were most likely to place *bomas* within 500m of the ridge crest because the soils near the top are well-drained, although steep slopes are avoided. A *boma* located at the base of hill slopes is at risk of becoming a dung and mud swamp, which increases disease risks for livestock and is uncomfortable for people. The first fields would be nearest the *boma*, close enough for the field to easily be guarded or weeded within earshot of children and sick animals. As more land was needed for the family, new fields are plowed below the first shamba, so that the newest fields of established bomas were found on the middle slopes. There is a tradeoff in placing fields near the boma: the best place for small children to herd smallstock is near the boma where they can be within the sight of their elders, but that also places the crops at risk of marauding sheep.[88]

The lower, concave slopes of an allocation were seldom farmed, even though in the ridged woodlands these would be the locations with the deepest soils. The lower slopes, even on the gentle rolls of the plains, serve important roles for livestock keeping. In the plains they were frequently flooded during the wet season, making them important watering points for livestock. As these black cotton soils dry, they contain salty vegetation important for livestock, particularly smallstock. The land immediately upslope is held as reserve for calves, smallstock and sick animals, maintaining accessible entry points to these little *engeseros* for adult animals and expanding the area available

[88] Three and four year olds are not always the most successful shepherds. Or crop guards, for that matter.

for grazing during the wet season (see Chapter 3). In the hillier areas of the village the lower slopes are not only *alalili* (calf reserves) but also important transport areas for livestock to reach wells dug into the river beds of seasonal swamps. The importance of the lower slopes for livestock goals was underscored by an Arusha agropastoralist, whose *alalili* was narrower than that of his Maasai neighbors but said even though the best soil on his allocation was at the base of the ridge, near the *korongo*, it was too important for cattle to plow.[89]

***The concern over soil fertility-where politics and ecology meet***

Soil degradation, as defined by Blaikie (1985), includes declines in soil fertility and structure created through the loss of vegetative cover and the subsequent physical loss of soil particles. Soil degradation has been at the heart of many central studies in human-environmental interactions. Many of these have had a political bent: political ecologists have examined the relationship between unequal power structures and soil erosion (Blaikie 1985, Blaikie and Brookfield 1987, Turner 1999), environmental historians have examined how historical events have influenced soil conservation programs (Beinart 1984, Anderson 1984) and agricultural change theorists have examined the role of increased population density in improving the soils and increasing agricultural output (Tiffen et al. 1994). The Dust Bowl in the American Great Plains during the 1930s may have been the first global environmental problem and a prime example of how international environmental disasters can have lasting, and sometimes misdirected, consequences. Anderson (1984) convincingly narrates the history of soil conservation in East Africa as the confluence of the Great Depression of the 1930s, the

[89] An alternative explanation is that fields near the *korongo* are more likely to be raided by wildlife. Still, a strip of a few hundred meters of bush is unlikely to keep wildlife out of any field bordering the *alalili*.

Dust Bowl, growth of the African population of East Africa after years of stagnation and drought during the 1920s and 30s. White settlers in Kenya, suffering from the loss of overseas markets and soil fertility decline brought on by years of cereal monocropping, used the images of the Dust Bowl and the rise in African populations to push for political solutions to both protect their place in Kenyan society and restrict Africans to smaller spaces. These local conflicts resulted in increased interference with African land use, even when some African groups practiced suitable soil erosion control measures developed indigenously (Anderson 1984). These efforts have had a long-term effect on the willingness of some African groups to undertake soil conservation measures[90] (Tiffen et al. 1994, Kikula 1999).

Soil fertility itself, not just its political construction, is critical to the maintenance of ecosystem functions. Savanna soils create and support landscape structure via soil moisture and nutrient patchiness (Belsky 1995). The stability of these soils is critical for long term sustainability. Models of rangeland grazing suggest regions with extremely long histories of grazing pressure are able to sustain heavy grazing while maintaining high plant species diversity and high resilience (Cingolani et al. 2005, Milchunas et al. 1988). African savannas have evolved with natural populations of large herbivores to sustain high ungulate and vegetation diversity: diversity which remained high even after the introduction of domesticated livestock. This resilience is extremely robust to fluctuations in herbivore populations (disease, drought), and climatic conditions (wet and dry periods, both semi-arid and mesic grasslands). According the rangeland scientists, this resilience is lost when the key resource, the soil, is dramatically altered. In

[90] As an agricultural development volunteer in the early 1990s the author was told by trainers that this political resistance to soil control, stemming from issues of land tenure and social control, was still a major issue in many areas of East Africa.

rangelands, high livestock and wildlife densities around water holes are associated with high levels of vegetation loss and increases in erosion, especially given the increasingly limited area available to pastoral peoples. The impact of cultivation on range soils has been noted (Mwalyosi 1992) but how pastoralists just learning to work within a cultivating or agro-pastoral paradigm utilize their soil resources is seldom commented upon (but see Anderson 2004).

***Soil dynamics and the new herder- farmer lifestyle (H3)***

Soil organic matter (SOM) was surprisingly low for a grassland region, although similar to that found by Solomon et al. for the Naberera area at the eastern edge of the TME (2000). Solomon, Lehman and Zech (2000) found cultivation of chromic luvisols in the TME at lower elevations reduced soil organic carbon by 56% and nitrogen by 51% during the first 3 years of cultivation. Application of manure and fallowing were found to increase soil organic matter and especially the large particles from which the most C and N was lost. The soil samples collected in this study were too heterogeneous and broad to draw similar conclusions regarding loss of fertility over time, yet nearly all samples with high levels of SOM were found in old boma sites, even after years of cultivation. While the soil data were inconclusive, the Maasai farmers of Loiborsoit are increasingly aware of soil fertility loss. The first fields on the Simanjiro Plain were located in Loiborsoit and plowed a minimum of thirty years ago. Given the low rate of fertilizer application or other soil replenishing techniques, this is plenty of time for those soils to degrade.

Traditionally, small maize *shambas* (farms) were often planted inside abandoned cattle *bomas*, making use of both the nutrient rich manure deposits and the thorny bushes

surrounding the former corral for protection against wildlife, so Maasai do know about nutrient enrichment. The labor involved in hauling manure to the fields is intense and mostly falls upon the women, who are generally not inclined to add to their already full workloads. Women travel great distances to collect water at least every other day and have many household tasks to be taken care of on their non-water collection day. With the increase in children attending school, another source of labor is unavailable to transport manure. Exceptions to this rule are the few *bomas* where women have direct control of their own fields: there were four such *bomas* in sample, two *bomas* of widows, all co-wives continuing to live in the same settlement to share resources, and two *bomas* of relatively wealthy elders with many wives. These women expect to feed their sub-families off of their own fields but also have the right to sell or distribute their harvests as they see fit. These women were more likely to put the effort into improving their soil resources.

Beyond soil amendments, fallowing, crop rotations and intercropping could improve soil quality and increase the length of time farming can be profitable within a certain field. Fallowing is likely to increase in the future, although many herder-farmers were uncomfortable with the idea of plowing more pasture than necessary. With pasture needs constraining the amount of land available for plowing, it is unlikely even when fields are fallowed they will rest long enough to replenish SOM naturally. As livestock are not only culturally important to the Maasai identity but also continue to be a major element in the local economy, the emphasis on pasture protection may actually decrease the potential for agricultural sustainability in this ecosystem, particularly without an increased commitment to manure application.

As mentioned in the introduction, some blame for declining soil resources and increased cultivation in Simanjiro has been laid on Arusha agro-pastoralists from nearby areas (NELSON 2005). While it is true that soil fertility is declining in Loiborsoit, most owners of the oldest soils are Maasai, not Arusha, and the Maasai are hesitant to expand their cultivation beyond a predetermined range in order to save room for livestock. While fields are usually expanded because of shortfalls in yields, this does not always occur in situations of *declining* yields. More often, a family is only able to plow a small area at first. When access to labor or capital improves, the fields are increased. O'Malley (2001) found Maasai herder-farmers in Loliondo who began to farm earlier began with smaller fields than those who only recently began cultivating. In my sample, while the newer fields did appear to be larger than the first fields of the past, they were still relatively small and unlikely to produce enough maize to match household needs (or expectations). This suggests that at this time, soil exhaustion is not a leading factor in field expansion, unlike I had hypothesized ($H_{3a}$). Additionally, Arusha immigrants in Loiborsoit are as likely to arrive from the distant slopes of Mt. Meru as from nearby Lokisale. Nearly all of them cited decreased access to farmland because of population growth as their reason for leaving their homeplace. In general these immigrants have a much better appreciation for the ability of soil to lose its fertility and many were actively involved in building more intensive soil protection structure.

## CONCLUSION

While the Maasai of Loiborsoit are remain culturally pastoralists, they are increasingly including cultivation into their subsistence pattern, attempting to maintain their herds under restricted and reorganized access to land. In this chapter I have

examined the constraints to cultivation in Loiborsoit and how residents cope with these problems, given that their major investment is still livestock. Herder-farmers identified several constraints to cultivation success, including rainfall, soil quality and management, and raiding by wildlife. Soil and wildlife are particularly amenable to management but doing so requires an investment of labor at odds with the labor requirements of pastoralism. Lack of access—to seed, labor, tractors—all make it difficult to improve their harvest and the sustainability of this emerging cultivation system.

While these constraints are hardly unique to the Maasai or to Loiborsoit, their impact in a space critical to other Tanzanian economic sectors, in particular the wildlife industry, has consequences beyond that of the survival of local residents and will thus make them a continued target for concern and activism by that industry. Two characteristics of local land management have a direct impact on the maintenance of the local livestock economy and wildlife populations. First, the emphasis still placed on livestock herding by local landholders, even those more heavily invested in cultivation, means that significant portions of the village landscape are kept in pasture. As land allocation continues in the village, particularly in the woodlands given the moratorium on new allocations within the plains habitat in order to protect migrating wildlife (AWF 2006), the maintenance of pasture reserves around bomas and farms certainly increases the long-term sustainability of the local livestock system. It can also help wildlife persistence. The ravines in particular are home to species important to the Tanzanian hunting industry such as leopard and greater kudu. Maintenance of *alalili* along those waterlines increases the amount of habitat available to these species and may decrease human wildlife conflicts.

More troubling from a sustainability and equality standpoint is the concentration of resources in the land allocations of those who received early allocations. While searching for appropriate fields for soil sampling, I found that most of the oldest fields were actually old boma sites, while very few of the newest fields were. This indicates the clustering of early fields with old homesteads and suggests newer homesteads do not have the same access to rich soil sites at the time of farm establishment. Those who received early allocations do not only have the closest access to water and pasture resources (see Chapter 3) but also the best soil resources for cultivation. Given the paucity of soil amendment practices in the village and the lack of will to undertake intensive soil improvement measures, those who gained land early in the allocation process may see higher harvests while using less labor. This would increase the resilience of their families as they will have to sell fewer livestock to make it through the dry season. If this proves to be the case, over the long term families who either chose not to gain an allocation after Loiborsoit incorporated or had no elders to gain an allocation at that time could find it difficult to stay in the pastoral sector at all. As poverty is a major factor in the desire to cultivate (Chapter 2), it could increase the area of land under cultivation and decrease the overall resilience of both the livestock and wildlife systems.

Despite this dire prediction, cultivation at current levels appears to be well within the capacity of the savanna system to support and has been crucial to the survival and maintenance of the local socio-economic ecosystem. The recent moratorium on new farm allocations in the plains will certainly test this by limiting the ability of smallholders to improve their access to better soils and decrease wildlife attacks. Similar to the situation with access to old boma sites, the decrease in access to the more productive

plains may have long term consequences for the poorest village residents, especially as residents of subvillages in the plains already have a high proportion of the village cattle wealth (chapter 2). In order to increase the sustainability of the current system, attempts should be made to educate local residents about improved seed varieties and soil fertility management. While some will embrace both technologies willingly, others will see it as effort they do not wish to take given their commitment to pastoralism. To counteract this attitude, the linkages between increased harvests on smaller plots of land and the protection of pasture land for livestock should be emphasized.

# CHAPTER 5

## CONCLUSIONS AND RECOMMENDATIONS

### INTRODUCTION

*The government has told us we should farm for many years now—even Nyerere told us to hold the jembe (hoe) in one hand and a cow in the other. Why are they complaining now that we have chosen to farm?*

-Maasai elder (*Landisi* age set)

This completed quotation, abbreviated in Chapter 2 (p. 58), embodies some of the exasperation with which Maasai residents of Loiborsoit regard the concerns of the wildlife community over Maasai adoption of cultivation. The Western myth of Africa continues to maintain an image of unchanging nature through history; of lions stalking across the savanna, giraffe silhouetted against the sunset and lean Maasai warriors, surviving only on milk and blood from their beloved cattle. Yet, as this dissertation has made abundantly clear, the savannas are (and continue to be) sites of intense transformation, both socially and ecologically. In fact, the concerns over potential transformation of the African rangelands began decades ago (Borner 1985). Residents of Loiborsoit are aware of these fears, but as Tanzanians feel they have legitimate alternatives to the vision promoted by the conservation industry. This dissertation attempts to examine how one of these alternatives, cultivation, has altered the human ecology of Simanjiro and what this bodes for the future of the savanna socio-ecological system. Traditional livestock production and small scale cultivation have very different constraints and requirements. I examined three different aspects of subsistence change in

Maasailand: changes in territorial and political ecology, how these changes have altered resource management and herding systems and finally, how Maasai are responding to production constraints as they relate to cultivation.

The Maasai have chosen to take Nyerere's directive to hold plow and cattle to heart—but not necessarily for love of Mwalimu.[91] In ***Plowing the Plains*** (Chapter 2), I examined two hypotheses regarding land use change in Maasailand. Prior research in Kenya and Tanzania tended to focus on either poverty, usually assumed to be the result of unchecked population growth, or land tenure insecurity to be underlying driver of pastoral land use transformation. It had been hypothesized that both drivers were working in Simanjiro but the details were not understood (Nelson 2005). This chapter investigated both poverty and land tenure using the mixed-consumption theme of agricultural change and concepts from political ecology, and then examined how these drivers fit together to instigate land use change. In Loiborsoit, Maasai appear to be poorer than historically, as judged by the number of cattle per person. In fact, 80% of the households have fewer than the five livestock units per capita necessary to survive on livestock alone. Additionally, the increase in smallstock herding suggests a greater commitment to the cash economy than in the past. The need for more income, to spend on clothing, school fees and health / veterinary care, suggests that the effective subsistence requirements have increased and that the toll on decreasing cattle herds necessitated diversifying into cultivation. Thus poverty is an important factor in individual land use decisions. Land tenure insecurities are also very high in Loiborsoit. These pressures led Loiborsoit initially to secede from a neighboring village whose

[91] Nyerere was referred to as Mwalimu (teacher), in respect for his occupation prior to becoming involved in politics.

chairman was selling land to commercial interests and later to plow the land in order to stake claim to rangelands otherwise seen as unproductive. Most recently, the village has attempted to use the interest of safari companies to build infrastructure in areas currently too dry to live in during the dry season. In this way, the loss of lands to conservation priorities, large-scale commercial farmers, and an increasing influx of non-Maasai farmers have led to a village- or Maasai-level drive to protect their remaining territories.

To examine how these drivers operated locally, I proposed that the driving events affecting poverty and land tenure have clustered together to create periods of intense pressure on the Maasai which have led to land use change. For example, the collapse of the national economy and veterinary services combined with land grabbing, drought and conservation pressures to initiate the land allocation process in 1988. Subsequent periods of land allocation show a similar confluence of drought, conservation concern and international/national economic policies. Because these pressures influence decisions at multiple organizational levels, attempts to broker agreements between the various stakeholders in Simanjiro, will necessarily require a multi-faceted approach, rather than attacking one problem at a time and hoping for resolution. Initiatives which only address one driver, poverty for example, will fail to counter community-level fears of disenfranchisement and possibly lead to greater land transformation.

In ***Compressing the Commons*** (Chapter 3), I described the evolving common property regime of Maasai herder-farmers after the loss of critical pastures to Tarangire National Park. My goal was to evaluate the robustness of the system for the maintenance of future rangelands. I found that Loiborsoit villagers have created a new grazing system that in some ways mimics the traditional system, keeping over half of the village land in a

designated village pasture zone. This pasture zone can only be accessed during the day until the middle of the dry season, when the village government, in conjunction with the elders, opens it for overnight use and temporary bomas. The result of this is that anywhere more than a half-day walk from the zone boundary is effectively a dry season pasture reserve. The traditional 2 day herding cycle is also largely in place, with around 40% of the surveyed herding cycles including at least one day on village pasture lands. The rest of the village land, the mixed-use zone, is managed under a patchwork of management types with allocated but unsettled lands being the most heavily utilized by livestock. Even though this system is, at this time, normally sufficient for the current farm and livestock densities, the idea that the zoning system can be a self-contained socio-ecological unit is both misplaced and unsustainable in the long-term.

Pastoralists have traditionally utilized mobility to counteract the great risks inherent in unpredictable semi-arid environments. The loss of grazing reserves and territory should increase the importance of mobility as local resources become scarce—yet it is precisely the mobile component of the savanna resource system which has been lost in land subdivision. Yet the internal village boundaries have arisen from a zoning process which was meant to stabilize and secure local land tenure. In fact, I found that reductions in mobility and the collapse of traditional regional management is decreasing the long-term sustainability of the land and increasing land tenure insecurities. The common pool resource system of the area has been completely reconfigured to fit the village model, even though a larger model would be more appropriate for spatially patchy pastoral resources.

The threats to these resources are twofold. First, critical livestock requirements are widespread but movement has been curtailed. The spread of cultivation throughout Simanjiro means that these resources are in danger of being lost. I found that in Loiborsoit, the pastures most vulnerable to the spread of cultivation, the unplowed but allocated lands, are actually the pastures most heavily utilized by herders. The loss of this land will increase the density of livestock grazing on the remaining pastures or force herders to travel greater distances, through more heavily grazed pastures, to reach water and forage in the village pasture zone. Second, despite the need to create more locally protected pastures for calves and smallstock, the fear of land sales to outsiders actually spurs on greater subdivision. Finally, by setting aside more pasture land than other Maasai villages, Loiborsoit has become a destination for herders as far away as Arusha town, even in relatively decent years. Within Simanjiro, movements between villages might be early signs of renegotiating a regional grazing plan, but during the field period there was little progress in creating a governing mechanism to handle the influx of non-Simanjiro livestock during the dry season. Theses stressors are signs that the zoning system in Loiborsoit has created boundaries which do not contain a socio-ecological unit appropriate for land use planning and indicate a system unlikely to be robust as cultivation continues.

Pastoralists are experienced in mitigating risk with respect to livestock herding in semi-arid environments. In ***The Ecology of the New*** (Chapter 4), I addressed farm management of Maasai herder-farmers. In particular, I was interested in how Maasai react to the constraints placed on cultivation. I hypothesized that the constraints to cultivation would influence the spread of cultivation and the development of a soil

conservation ethic among new herder-farmers. Using a combination of methods—ethnographic surveys, participant observation, surveys of soil and crops—I found both wildlife and soil attributes, largely water holding potential, have influenced agricultural patterns in Loiborsoit. In general, the soils are relatively nutrient rich, particularly in phosphorus, but moisture availability is an issue and knowledge of farming management is limited. The heavier soils of the plains and transitional woodlands promote moisture retention and are higher in nutrients than the ridges. According to informants, crop raiding by wildlife is also much worse in the ridges. Both of these constraints have led some herder-farmers with *uwezo* (capital and access) to move their farms to the plains.

*Uwezo* impacts the success of cultivation in multiple ways: lack of access to improved seed, tractors or healthy oxen, labor to weed, guard, haul manure or build terraces, and prime land make it difficult to improve harvest. This makes it more difficult to increase the sustainability of this emerging cultivation system. Pastoralism is a food pathway requiring significant land and labor requirements that limit the *uwezo* available for cultivation. For example, very few farmers are adding manure to their fields, despite its ready availability. In the absence of trailers for draft animals, manure must be carried to the field one sack or bucket at a time. It is difficult to gather the labor needed to shift as much manure as necessary from cattle kraal to crops. Space is another issue: with the decrease in mobility described in Chapter 3, herder-farmers must maintain a personal pasture reserve on their allocation, limiting the amount of land they can fallow and still maintain sufficient acreage to feed their families. The number of years a field was farmed was not shown to be a factor in the status of nutrient levels in the sampled fields. However, the main predictor of nutrient rich soils found in the soil analysis was the

presence of an old boma site in the field. Given sufficient labor, this could be easily replicated in fields without these sources of manure. Given the recent vintage of most Loiborsoit farms and the relative inexperience of the herder-farmers, it is not surprising that few are deeply interested in intensive soil remediation. However, many farmers mentioned they were starting to see changes, so the lack of *uwezo* may soon play its part in the sustainability of Loiborsoit's soil resources.

Finally, traditional land use patterns, land allocation history and the usual trajectory of field expansion exacerbate inequality in the village. During soil sampling, I found that most old boma sites were in the oldest fields, with but very few in the newest fields. This suggests newly allocated lands may not have the same access to rich soils sites as earlier farms. Historical land use patterns and the history of land subdivision have concentrated the richest sites, those with old boma sites and access to water and protected pastures (Chapters 2 and 3), into the hands of those who received the earliest allocations. Even though the village is committed to maintaining large pasture reserves, poverty is still a significant driver of land expansion (Chapter 2). The unequal access to resources could increase poverty levels over the long term and decrease overall resilience.

## MAJOR THEMES

Several themes emerge from these analyses. I will highlight three of these themes here: the unintended consequences of conservation, the importance of historical social relations in the creation of the current and future landscape around protected areas and the prospects for long-term resilience within the savanna socio-economic system. I close

by offering a series of recommendations for the future of land use planning and poverty alleviation in Tanzanian pastoral areas.

### *Conservation and consequences*

All actions to preserve biodiversity have consequences. Some of them are positive—the preservation of rare species, the maintenance of open space and protecting environmental integrity are positive goods for everyone, even those who do not yet necessarily appreciate it or have other, more immediate needs.[92] It is very possible that without the implementation of conservation measures in northern Tanzania, some of the last major collections of megafauna in the world might have been lost through uncontrolled hunting by western tourists during the colonial era, or for the bushmeat trade after independence. Additionally, the industry which has arisen around the infrastructure of wildlife conservation has been a tremendous boon to the economies of both Kenya and Tanzania, the countries where Maasai reside. As early as the late 1800s, the colonial authorities courted tourists from Europe and the Americas by presenting to them the image of unbelievably free and huge herds on the plains (Steinhard 2006). Their advertising both created the image of wild Africa and ensured that future post-colonial governments would be dependent on tourism revenues for their national budgets.

East Africa has been occupied for tens of thousands of years. Human land-use practices, from additional fire, to grazing competition with wildlife and 500 years of ivory exploitation, created the landscape found by Western explorers in the 19th century. Due to the interrelated ecologies of humans and wildlife, other consequences of

[92] We don't all have to appreciate something for it to be worth saving. Literature, art, music--these are all appreciated by many but not by all, nor the same thing appreciated by everyone. This seems obvious but when translated into conservation in practice, the differences in values, wealth and power make this difficult to discuss without argument.

conservation initiatives are inevitably negative, for both Maasai pastoralists and for wildlife protection itself. Some are fairly easy to recognize and well-known, such as the compression of the commons and fragmentation of traditional grazing routes. As I explained in Chapter 3, the traditional Maasai grazing systems included pasture reserves, pastures with permanent water sources which were only utilized during the driest seasons. In Tanzania (as well as other countries), national parks are nearly always centered on permanent water sources, overlapping these dry season pasture reserves and removing them from pastoralist use. This has compressed all the pastoralists in an area into wet season grazing lands all year long. Even as early as 1971, only one year after the creation of Tarangire National Park, a small drought created competition for water resources and conflict between pastoralists and their agricultural neighbors as Maasai left the Plains in search of water and fodder (Kahurananga 1976). The loss of critical grazing lands thus may increase poverty and strife by decreasing the ability of pastoralists to maintain their herds during bad years. Conservation initiatives can increase antagonism with local groups by not allowing for compensation for lost lands or reciprocal access to the wildlife's resources in bad years: this may indirectly sabotage positive conservation outcomes.

The research presented here adds to the greater body of knowledge about the negative effects of conservation, particularly the substantial literature on the Maasai. There are two areas in which this dissertation expands on previous research in other areas. First, most research in Simanjiro has examined more regional scale effects of pasture loss on the Maasai herding system. This research examines how conservation has influenced even very local decision-making. Conservation initiatives limit the options

available to a household, whether they are debating opening a new field in a different subvillage or where to herd animals in the new commons. These new, local scale effects on grazing patterns have not been closely examined before this research. Secondly, by indirectly encouraging Maasai to plow the land rather than cede it to wildlife, conservation initiatives have a bearing on a whole host of other sustainability issues that are likely to affect the future of wildlife protection. In a sense, the loss of pastures has forced pastoralists to develop alternative economic strategies years before simple population growth would have made diversification necessary.[93] Many farm to alleviate poverty but even those who do not need to farm for food are encouraged to plow the land by their local government in order to protect the land from outsiders. The development of conservation zones to protect wildlife has created the conditions for the development of land use choices inimical to wildlife preservation outside protected areas—areas critical to wildlife conservation yet outside of protected area boundaries.

***Role of history in driving stakeholder responses and landscape change***

The landscapes of Simanjiro today, like all landscapes, are the result of past land use decisions. This is a deceptively simple statement. It hides all of the complexity I have struggled with in this dissertation; by hiding in plain sight the interrelated effects of ecology and social structures, this statement implies that we should easily be able to read the landscape for past use and past resource conflict. While we can see where a boma was sited for some time after abandonment by characteristic grasses and trees formed in a circle, and we can assume that the creation of park boundaries in formerly unbounded

[93] I realize protected areas are not the only form of enclosure on the savanna; immigrating cultivators and large scale commercial farms are also involved. Yet the loss of the pasture reserve for Simanjiro can be laid at the feet of Tarangire National Park.

space will have repercussions on the people who used to access the protected resources, the intricacies and interrelations may be harder to pinpoint but equally as important.

In Loiborsoit, all decisions about land are made within the context of threats to land tenure from outsiders (both for agriculture and conservation), falling cattle numbers, environmental stochasticity and increasing cash needs. That is not unusual in itself—land use decisions are hard everywhere. But what I want to emphasize is the clustering of specific events which have led to changes in the way residents approach land tenure and land use. One of the driving questions in Plowing the Plains (Chapter 2) was to describe how these different stressors, aggregated into poverty and land tenure insecurity, interact to push Maasai to farm. This dissertation clarifies the influences of these decisions, which include the history of interactions between actors. Of particular interest is the role that fear has played—the fears of the conservation organizations, the fears of the Maasai—both are the results of a long history of poor interactions and power struggles between these groups. Without the loss of the Ngorongoro Crater and the Serengeti National Park impacting the Maasai psyche, emphasized by the specter of the Simanjiro Conservation Area, would Maasai have been more likely to negotiate with conservation groups in order to maintain open pastures in critical sites? Would Maasai have chosen subdivision as an appropriate response if it weren't for the confluence of conservation initiatives with economic downturns at the national level? The most recent move, the moratorium on new farm allocation along the migration routes and possible removal of all fields from the plains comes on the heels of the worst drought in 50 years and is unlikely to engender additional Maasai support. The history of these two groups, the wildlife community and the Maasai community, is filled with tension that infuses all

land use decisions on the savanna and no doubt continue to frame these decisions in the future.

The legacy of historical land use has being shown to have long term impacts on ecological communities and ecosystem resilience (Foster et al. 2003). Local land use and the history of land allocation can also have long term impacts which may set up future choices and attitudes towards land use, partially through the influence of land use on ecological communities. Those who gained land early in the allocation process, i.e. those who were in political control as Loiborsoit became a registered village, gained access to resources which can have long term impacts on a smallholder's success as both a pastoralist and a cultivator. These include user rights to grazing resources and water, as well as access to the good soil in old *boma* sites. Future research on the impact of these land use decisions, based on vegetation surveys conducted during this fieldwork and archival evidence of past vegetation and ecological characteristics, should help tease out the more subtle changes in ecology due to land use transformation and hopefully will help to understand the impact of past land use decisions on future landscapes. This brings me to the final theme: resilience.

***Resilience***

The concepts of unequal access to resources and land fragmentation have major implications for the future resilience of the socio-ecological system of the Simanjiro savannas. Holling and Gunderson (2002) describe several distinct stages which may indicate resilience: the exploitation and conservation of resources leads to elements of the socio-ecological system become increasingly fragile. In their model, as the system becomes increasingly hierarchical, with all available energy used, it becomes more brittle

and more susceptible to collapse. The release point follows as the system breaks down and then reorganizes before another, new exploitation phase is begun. The ability of a system to withstand changes in this cycle without fully shifting into a new stable state is ecosystem resilience. A resilient system requires both redundancy and flexibility.

In semi-arid areas, connections between resources and social groups increase flexibility and persistence for social and ecological systems. However, the persistence of the savanna system suggests that the basic system is very resilient to shifts in the basic ecosystem state. Grassland modeling suggests that savannas can absorb large shifts in resource use and still recover when given the opportunity; they are not lost to the savanna system (Cingolari et al. 2005, Michulnas et al. 1985). The increase in boundaries and land fragmentation in the savannas of Simanjiro are tying up resources, severing the connections which provide stability and flexibility, reducing the opportunity for recovery and increasing the brittleness of the system. At a local scale, Maasai herder-farmers and Arusha agro-pastoralists are altering the conditions that have supported resilience and persistence, intensifying and increasing the probability of a whole system shift to a new state. At the moment it is hard to see how much plowing can be absorbed by the system and still remain flexible; there are simply too many unknowns.

Part of the uncertainty in the ecological resilience of Simanjiro stems from the uncertainty in the social impacts of land use transformation. Traditional Maasai society is both flexible and highly connected. Multiple contacts and the willingness to use them are necessary to follow resources and maintain different resource networks to shift with climate and societal shifts. In the past, risk was spread out across the social as well as natural worlds. A wealthy man knew he was just one epizootic or drought away from

being a poor man. The warrior age-grade helped minimize this risk by providing contacts and stock-associates[94] to regain access to herds after catastrophic loss. Declining herd sizes have decreased the ability of a herder to restock their herds after a catastrophe. Land allocation has also concentrated prime grazing and cultivation resources in the hands of those families who gained land in the earliest stages of the subdivision process. This is an additional constraint on a poor herder trying to regain stock and reinvent themselves as a successful herder-farmer. The need to protect one's allocation means bomas are subdivided as well, leaving few households in a *boma* to assist with herding labor and thus adding to the labor constraints faced by a herder-farmer trying to successfully integrate the two systems.

While socio-ecological systems are linked, they may not operate on the same time or spatial scales (Holling and Gunderson 2002). The emergence of the new land use system in Loiborsoit suggests there is and will be a certain level of instability as the new system settles in and herders learn how to incorporate, not just append, cultivation into their production system. Whether the system is allowed to settle down is somewhat dependent upon the reactions of more powerful stakeholders in the region, i.e., the wildlife sector and the Tanzanian government. Current attempts to resettle squatters from Arusha town to nearby villages (Selasini and Waigwa 2007) and the recent farming moratorium suggest the new system will entail struggles as its becomes defined. The ecological impacts of this transformation will probably not occur simultaneously. The two parts of the system, the social and the ecological, are linked but not tightly, there will be a lag time before the ecological results are seen in both human and non-human communities. This lag will complicate land use planning: those interested in the

[94] Friends with whom animals are exchanged.

persistence of wildlife populations will likely not judge the resilience of the system on the persistence of smallholders and pastoralists, and vice versa. In this ancient system, it would be a tragedy if some flexibility and multiple-use agreement could not be developed.

## CONCLUSION AND RECOMMENDATIONS

The experiences of Maasai are not unique-- the political ecology literature is replete with references to the conflict between common areas and biodiversity preservation worldwide (Robbins 2004, Sundberg 2003). Land loss and negative conservation outcomes are threaded through the major themes in political ecology outlined in Chapter 1 (Table 1.1, p5, based on Robbins 2004). Many of these studies seem to pit traditional land use against conservation, even though traditional land uses can be equally as unsustainable as modern resource use and are no guarantee of long-term sustainability, especially under conditions of high population growth. Many traditional land-uses are sustainable precisely because of low local population densities. However, the arguments used by development agencies and conservation organizations to legitimize land alienation were based upon the false premise of open access systems. The real tragedy of the commons is that policies developed to ostensibly protect the environment have actually led to a situation where formerly managed pastures may increasingly not be managed at all. In this new situation, regional management is fragmented into very localized management, at the household level, despite the necessity of wide territories and mobility to survive in difficult and unreliable environments.

Conservation conflicts are human rights issues with environmental consequences. Despite this, as geographer Paul Robbins recently said at a national conference, "*Conservation happens. Deal with it*." At this point those working with people living around protected areas or who have otherwise have lost access to traditional resources, must work with all stakeholders in the region to improve their situation and to reorganize alliances for natural resource protection and sustainability. In this spirit, I offer the following recommendations to for future land use planning, poverty alleviation and building socio-ecological resilience in the East African pastoral areas.

***Recommendations***

1. Improved extension services to illustrate good farming practices.

Small scale cultivation does have some promise for supporting lower-level involvement in the pastoral sector and the maintenance of open pastures. As I stated in my conclusion to Chapter 4, recent moves by the government and conservation community to protect the plains from cultivation is likely to reduce the ability of Maasai herder-farmers to improve their access to better soil and decrease wildlife attacks on croplands. While many Maasai may not wish to undertake the extra labor to improve soil fertility or spend the money for improved seed varieties at this point, in the future, the decreasing access to both fertile soil and pasture resources may make this a palatable alternative to migration in search of paid labor. Therefore, local agricultural officers need to be educated in dryland farming techniques and supported in order that this information and training can be available for all residents. During the time I lived in Loiborsoit, the local agricultural officers were seldom seen, unlike comparable areas in Kenya and more cultivation orientated locations. Small scale cultivation cannot be the

answer to all of the problems in Loiborsoit, particularly given the questionable climate for maize production. However, like conservation, it is happening and should be directed. While some Maasai will embrace these technologies willingly, others will be doubtful given their commitment to pastoralism. The linkages between increased harvests on smaller plots of land and the protection of pasture land for livestock should be promoted to increase savanna resilience.

2. Increased education and employment opportunities outside of resource intensive sectors.

While education is not a panacea for all problems, the extremely high rates of illiteracy and school truancy in Simanjiro make it difficult for a young person to find any work outside of livestock or cultivation. Even within those sectors, increased education would be an asset. Given the high levels of illiteracy, very few households are able to keep track of yearly income and expenses. Therefore I have three specific recommendations to improve the overall education and success rate of Simanjiro residents:

a. Adult education focusing on basic mathematics and bookkeeping. Some of the most successful herder-farmers in the village kept detailed logs of expenses. They knew exactly how much livestock keeping and cultivating the land cost them each year and were able to make livestock and cultivation decisions based on their calculations and goals. This is a difficult skill and one frequently taught by development agencies targeting small business owners. All smallholders are essentially small business owners in a mixed-consumption farming system. There are many small non-government organizations (NGOs), including local Maasai NGOs which could undertake this task.

b. A technical training school for livestock. At one time Emboreet village hosted a secondary school specifically for livestock training. It was well thought of within the Maasai community but troubled finances caused it to close in the 1990s. My conclusions suggest that savanna resilience would be supported by maintaining large areas in pasture. Successful livestock husbandry would have a positive effect on maintaining open pasture, as well as providing an outlet for the educated youth from the many primary schools. During the field period, frequently rumors were heard that the school would reopen and the reaction from informants was always positive.

c. Funds from TANAPA have been used to build primary schools in Loiborsoit and other Simanjiro villages. Yet there is only one secondary school in the entire district and very few government (reduced rate) secondary schools nationwide. The cost for sending a child to a private secondary school can be prohibitive, especially when a family has many children. TANAPA and development NGOs interested in conservation should create a scholarship fund to send the young people who graduate from Simanjiro primary schools to secondary school. By educating the youth, these groups would be training young people for paid work in the urban areas, giving residents added revenues to support their families on smaller cultivated areas and reducing the population living in the district.

3. Institutional support for regional land use planning and the maintenance of flexibility.

The resilience of the socio-ecological ecosystem should be the goal of land use planning in Simanjiro, given the multiple stakeholders and histories. Flexibility has been the hallmark of this resilience, supported socially by the common pool resource grazing system described in Chapter 2. Changes in territory and the responses to these changes

are leading to a new CPR system. The emergence of this new common property regime will take the support of the national government and the wildlife sector, including the willingness of those sectors to accept some mistakes made by herder-farmers as they attempt to renegotiate their new production system. Support could be shown for the new CPR system through the adaptive management process outline below, especially through the reduction of fears of land loss and increasing land tenure security.

4. Adaptive management

This recommendation is the most likely to be attempted but also the most difficult to undertake. Under the current system, efforts are made by the conservation authority to gather stakeholders together and listen to their concerns, but final decisions about management, even on land outside the national park and not really within the purview of the wildlife sector, are made by the wildlife community. It is possible and necessary to integrate the concerns of those living outside the national parks with the concerns of the wildlife communities to *jointly* manage the ecosystem to support specific outcomes agreed upon by all parties. This will take time and effort and an unusual amount of trust on all sides of the issue. Given the history of park relations described in this dissertation and elsewhere, this is a particularly thorny issue. However, it is probably the single most important move towards sustainability the park system could make. I suggest a program imitating those being implemented elsewhere (Pearsall et al. 2004). Using an iterative process, hypothetical scenarios for the future can be debated and specific measurable outcomes chosen by all stakeholders. These outcomes are then measure success at regular (5 year) intervals in a transparent process. Despite the technical nature of much of the discussion, the *process* of discussion and open debate fits in well with Maasai

decision-making protocols. There are many conservation emergencies in Africa: many would decry the time wasted on this process, when maintaining and increasing hard conservation boundaries might be more expedient. However, because of the redundancies in the savanna system, there are plenty of similar parks and wildlife assemblages in East Africa. This could be a great experiment in modern conservation planning, and more inclusive than other attempts at adaptive management on the continent (du Toit, et al. 2003). While it is unlikely Maasai would regain access to the park, even during the driest year, the debate, and the understanding it would provide for all parties, would be invaluable. The adoption of a true adaptive management approach, I believe has the greatest hope of achieving a resilient future for all residents of Simanjiro.

## APPENDIX A:

GLOSSARY OF TERMS USED

| Word: | Origin: | Definition: |
|---|---|---|
| *Alalili* | Maasai | Pasture reserve, usually refers to smallstock and calf reserves. Highly protected. |
| Age set | | Group of men roughly the same age who are circumcised within a few years of each other and who are given a group name and identity. As a unit, these men then move through successive age grades (boys, warriors, elders). |
| Arusha | | Either a major town in northern Tanzania or an ethnic group of Maa-speaking agro-pastoralists whose traditional area encompasses Arusha Town. |
| *Boma* | Swahili | A group of households who live together in order to share herding labor and resources (Maasai: *enkang*). |
| *Engusero* | Maasai | Seasonal wetland. Important grazing area for smallstock in particular. Black cotton soils. |
| *Euwas* | Maasai | Open area, plain or savanna. |
| *Iloshon (pl. Olosho)* | Maasai | Geographic organizational group of Maasai, section. |
| *Imparnati* | Maasai | To become settled'; in Maasai areas, Operation *Vijiji* was known as Operation Imparnati. |
| *Kisongo* | Swahili | Maasai section most prominent in northern Tanzania |

| | | |
|---|---|---|
| *Kitongoji (vi-)* | Swahili | Subvillage (s). |
| *Korongo* | Swahili | Dry ravine or intermittent streams. Water can be obtained by digging in the sand but only flows just after rainfall. |
| Maasailand | | Areas of East Africa traditionally inhabited by Maasai. |
| *Mbalozi* | Swahili | Ten-cell leader; the most local form of elected official. Their main activity is dispute arbitration. |
| *Murran (il-)* | Maasai | Warrior age-grade. |
| *Olng'esher* | Maasai | Age-grade ceremony when *ilmurran* become elders (*orpayani*). In many ways, this marks the political beginning of a man's life. |
| Operation *Vijiji* | | Villagization; the process by which the newly independent government of Tanzania attempted to enforce African socialism by resettling citizens into newly created central villages for collective agricultural production. |
| *Ujamaa* | Swahili | African socialism ("altogether"). |
| *Uwezo* | Swahili | Capital, social or monetary. |

## APPENDIX B

LOIBORSOIT CALENDAR

**Maasai Calendar for Loiborsoit, Tanzania**

| | |
|---|---|
| 2000 | Njaa (hunger) |
| 1999 | Jua sana (hot sun); lari langolong |
| 1998 | Korianga age set begins to be circumsized |
| 1997 | 2nd Engebata of Korianga age set |
| 1996 | |
| 1995 | 1st Engebata of Korianga age set |
| 1994 | Njaa (little rain, lots of bugs) |
| 1992-93 | |
| 1991 | Enuoto of Landis age set |
| 1990 | Isinyie (a sub set of Landis circumsized) |
| 1989 | same as 1990 |
| 1988 | Makaa age set retires; Nadunguni sub set of Landis circumsized |
| 1987 | Il rangish; ngai ya Olmakaa (First part of the Makaa Olng'esher ceremony) |
| 1986 | Karanga |
| 1985 | Mbulunge |
| 1984 | Sipolio of Landis begun. Sokoine died |
| 1983 | 2nd Engebata of Landis |
| 1982 | |
| 1981 | 1st Engebata of Landis |
| 1980 | Solar eclipse |

| | |
|---|---|
| 1979 | |
| 1978 | Enuoto ya Makaa |
| 1977 | Operation vijiji |
| 1976 | |
| 1975 | Seuri ate set retires |
| 1974 | posho manjano famine (yellow maize, after US relief maize meal) |
| 1973 | Rang Rang circumcised |
| 1972 | Laiboni Shinini dies |
| 1971 | Irange circumcised |
| 1969-70 | Makaa age set begins circumcision |
| 1965 | Enuoto of Seuri |
| 1960 | Seuri circumsized |

Few Maasai reference history in terms of Western years, or even the Julian calendar. During interviews and discussions, it was helpful to have a calendar based on local events. The following calendar was based upon a calendar created and used by the local Pentecostal Mission. Where possible, I have added additional references points.

Note: Ndagala (1992) dates the Seuri age group from 1955, which is more plausible than the date given by the calendar this is based upon.

## APPENDIX C

MAASAI AGE SET NAMES USED IN SIMANJIRO

| **Maasai names** | **Period of warriorhood** |
|---|---|
| Korianga | 1998-present<br>Eunoto: 2005 |
| Landisi<br>(*Irkidotu*) | 1984-2002/3<br>Eunoto:1991<br>Olng'esher: 2002/3 |
| Makaa<br>(*Irkishumu*) | 1971-1988/9<br>Eunoto: 1978<br>Olng'esher:1987 |
| Seuri | 1955-1974<br>Eunoto: 1965<br>Olng'esher: 1974 |
| Meshuki<br>(Ilnyankusi) | 1935-1958 |
| Ilterito | 1926-1947 |

Note: Names in italics are alternative names, given at the Olng'esher. These names are more respectful than the warrior name, but Makaa was frequently still used in Loiborsoit. The Landisi did not receive their respectful name until the end of the field period. Dates based on the Loiborsoit Calendar, supplemented by Goldman 2003, O'Malley 2000, and Ndagala 1992. This table uses the Ndagala dates for the Seuri period of warriorhood.

## APPENDIX D

RETURNS TO VILLAGE

*Utafiti yako, itasaidia sisi?* –This research of yours, it will help us?

*Utat usaidia vipi*? –*How* will you help us?

> -Questions asked of the researcher by a village elder and member of the village council.

These questions were asked many times, by many different men. Maasai are well aware of the multitude of PhDs completed by westerners on Maasai life and culture and also of how little they have profited by this attention. At first I had no idea what to answer to this question—my research could benefit villagers by improving the extension services provided by District offices for example, or make things more difficult for the villagers by attempting to articulate the conflicts between Maasai and the wildlife industry (not that this dissertation does this full justice, nor is it the only reference in print on that issue). Additionally, there were multiple levels of organizational scale to which I needed to appeal: households can be helped individually but the village as a group, whether they were involved directly in my research or not, needed to approve of and assist my work.

Over time we developed a place in the village structure, a social location in our neighbors' risk minimization attempts. My husband and I lived in the center of the village, right off the main street and near the village shops. We were easy to find when things were difficult or when someone was headed to the bar and needed a few shillings for beer. As owners of one of the few full-time vehicles in the village (and the only who didn't charge gas money), we were the village emergency service—it was to us people

came when a family member was seriously ill or hurt, although we drew the line at carrying dead bodies. We carried children and pregnant women to health clinics in nearby villages and then to Monduli or Arusha town when those clinics were out of medicine or failed to heal a patient. We were a source of income for several families and fed many others every day who just 'happened' to pass by our '*boma*' at lunchtime. My sample *boma*s also gained from our visits: each time I visited a family for a long interview I carried tea and sugar for each sub-household (*olerai,* each wife's household). Most women must find the money to purchase these items for their household and at times sub-households can go many weeks without sugar in particular. After sampling soils, each farmer was given (verbally, for the most part) a description of the soil characteristic in the field I sampled. But it took longer to develop a more consistent and constructive way to help the entire village.

Early in 2002, the village leaders came to us with a proposition. The leaders knew we were looking for some way to return village hospitality: we had tried to fix several hand-powered water pumps in the village soon after arriving but had failed to find the right equipment. For their part, the leaders had promised the village they would set up a monthly health clinic in the village, bringing the doctor from the government health clinic in Emboreet (south of Loiborsoit) to Loiborsoit every month for pre- and post-natal visits and child immunizations. They asked us if we were willing to provide the transportation until we left, after which they would take over (assuring us that they were putting money aside for such purposes). We happily agreed. After that, on one Thursday every month either my husband or I drove to Emboreet, collected the doctor and nurses with their medicines, and brought them to the village office in Emboreet. Sometimes this

involved quite a trek, as Emboreet was surrounded by a swamp of sticky black cotton soil in the wet season. We carried on this project throughout our time in Loiborsoit, even leaving money for petrol with my assistant to cover the first several months after we had returned to the U.S. By bringing the mobile clinic to Loiborsoit I was able to do something concrete for the village that was helping me gain a doctorate and satisfy critics in the village that I was useful after all.

## APPENDIX E

SOIL SAMPLING

Soil sampling was a learning experience on many different fronts. The purpose of the sampling procedure was two-fold: first, to provide a baseline picture of soil resources being farmed in Loiborsoit, and secondly, to ascertain, if possible, what effect small-scale farming is having on the soil. Widespread cultivation is still a relatively new enterprise in the village; therefore not all slope/habitat/age combinations were obtainable. First attempts to find fields of the appropriate age and habitat class were drawn from the random sample of bomas used for the socio-economic portion of the study; all but one soil sample was obtained from this subset of village *bomas*. I abandoned the management variables along the lower slopes quickly: very few residents farmed this portion of the slope as this area was left open for smallstock and calf grazing reserves (see Chapter 3), or contained too much clay for easy plowing (Chapter 4). Fields of all age classes and habitats were easily found along the upper slopes. Several additional samples were obtained from fields with interesting features or histories, such as old boma sites both farmed and unfarmed, in fields near termite mounds and an old fallow field. I admit that much of the soil sampling was driven by curiosity as much as plan. During the analysis portion of the study a fourth variable was included to describe fields located on former cattle boma sites.

Each sample was a sub-sample collected by blending samples of soil from across each field together and extracting roughly a kilogram of the mixed soil. A description of each sampled field was recorded, including its size, the presence of termite mounds, observations of crop condition and weeds and trees species found the fields and a

description of field's management history. These samples were then taken to at the Selian Agricultural Research Institute (SARI) in Arusha, 3 hours from the research site, and analyzed for nitrogen, available phosphorous, organic carbon, cation exchange capacity and base saturation. SARI is the Tanzanian office of CIAT in Africa, the International Institute for Tropical Agriculture. I received the results of the soils analysis from the head of the Soils Laboratory, Mr. Ramadhani Ngatoluwa. After learning what I could from him about the critical levels of the variables, I visited most of the sampled farms personally and explained the results to the farmers. Some farmers were out of town and I was unable to reach them before leaving the field. I left complete descriptions of the soil variables and results in Swahili with my assistant, Isaya Ole Samweli.

*Statistical analysis*

Soil data were examined in the open source statistical package R (R Core Development Team 2006). Because the structure of the sampling scheme necessitated finding and filling specific slope/field age/habitat combinations, some of which were unavailable, randomized sampling was impossible to obtain. Variation within the soil sample units was high, suggesting a less homogenous geology than expected. In fact, greater understanding of the system was provided by the act of sampling, attempting to find soils that fit the a priori categories, than from the results themselves.

Because one of my goals was to develop a baseline of some Loiborsoit soils, I present the raw data points in the next several figures, along with the sampling scheme. They are shown graphically by age, habitat and slope position. The red dotted lines indicate critical nutrient levels as defined by Charmen and Murphy (2000). Please see Chapter 4 (**Ecology of New**) for more analysis.

## E.1 Sampling scheme for soil samples.

| | Plains | Transitional | Steep woodlands |
|---|---|---|---|
| **Top Slope** | Unplowed<br>New fields (1-2 yo)<br>Fields 4-7 yo<br>Fields >13 yo | Unplowed<br>New fields (1-2 yo)<br>Fields 4-7 yo<br>Fields >13 yo* | Unplowed<br>New fields (1-2 yo)<br>Fields 4-7 yo<br>Fields >13 yo |
| **Middle slope** | Unplowed<br>Fields 1-2 yo<br>Fields 4-7 yo<br>Fields >13 yo | Unplowed | Unplowed<br>Fields 1-2 yo<br>Fields 4-7 yo |
| **Lower slope** | Unplowed | Unplowed | Unplowed |

**Notes:** Sampling scheme for soil samples. "Habitat" denotes vegetation and general topography of site; Plains are open grasslands with rolling topography, Woodlands are wooded grasslands with nearly complete tree cover but rolling topography, Steep Ridges are ridge and ravine zones with very steep slopes. No fields were found on the lower slopes in the village, and too few in the middle slope to gather sufficient samples in Savanna woodlands. Nor were there enough old fields in the ridged woodlands at the middle slope to complete the matrix. At least 3 samples were obtained at all locations except for *, were only 2 fields were found.

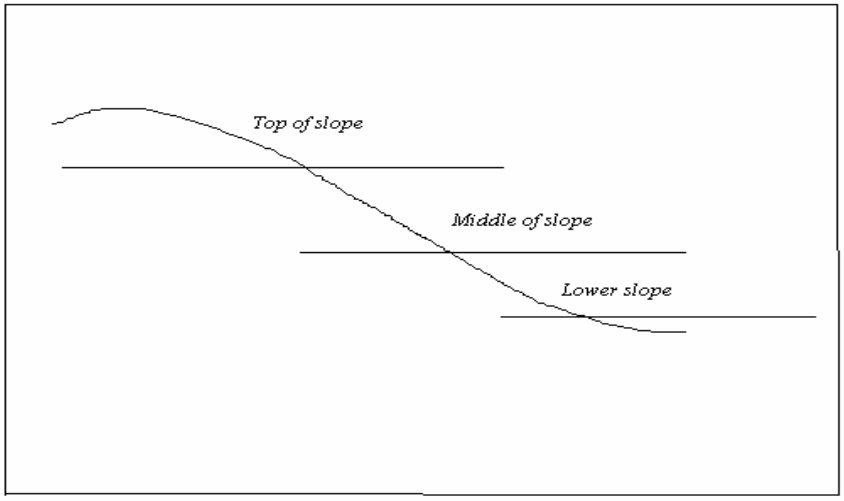


**Figure E.2** Generalized sampling position along slope. The concave valleys were avoided because there were few farms in this space village-wide. One sample was very close to the depression and was extremely sodium-rich, indicative of the black cotton soil found in seasonal wetlands.

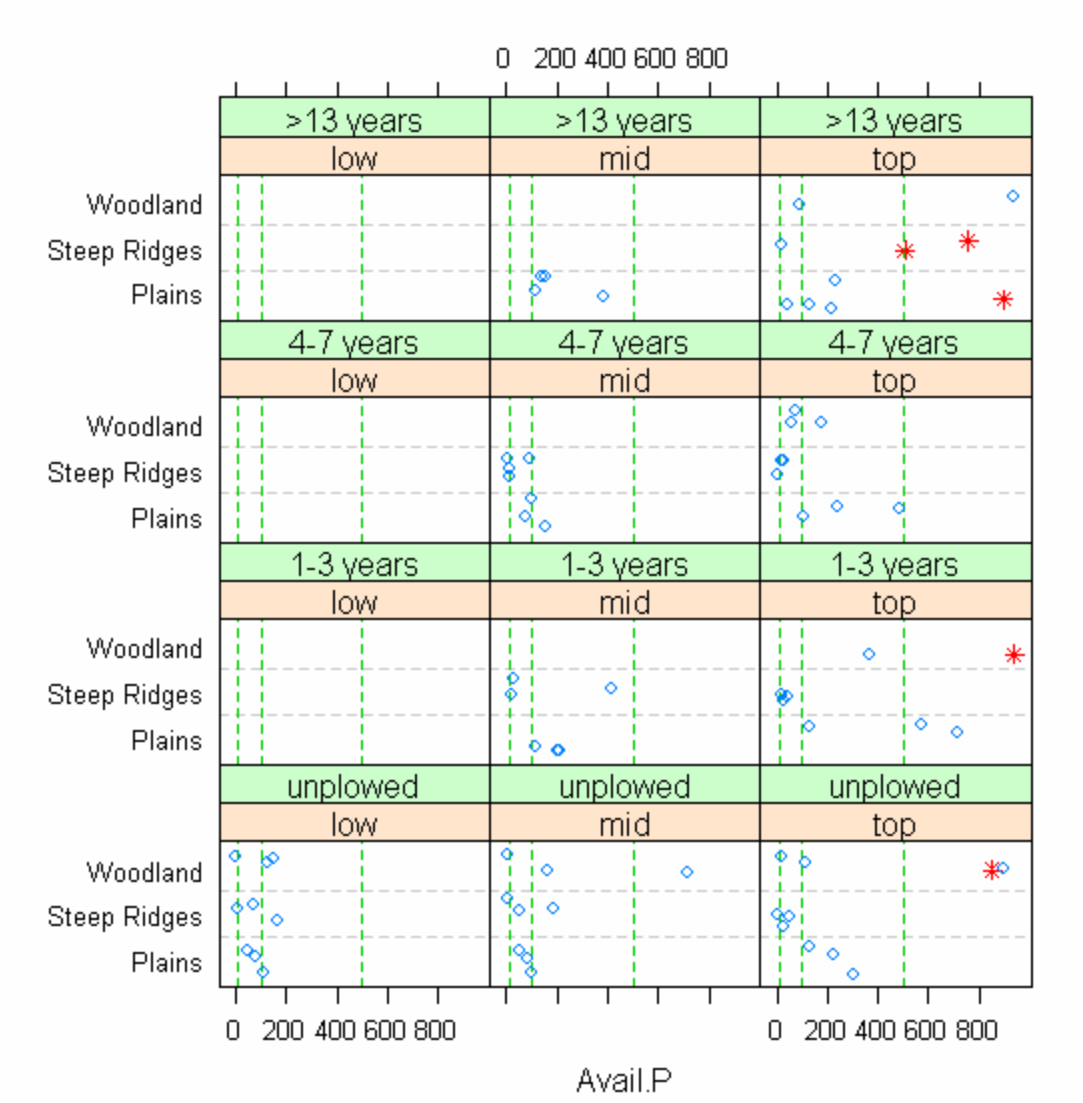


**Figure E.3** Amount of available phosphorus in the soil samples in mg/kg. The raw data is displayed by habitat, slope and age of field. The asterisks denote an old boma site. Vertical green lines indicate cutoff points for soil quality: (Charman and Murphy 2000)

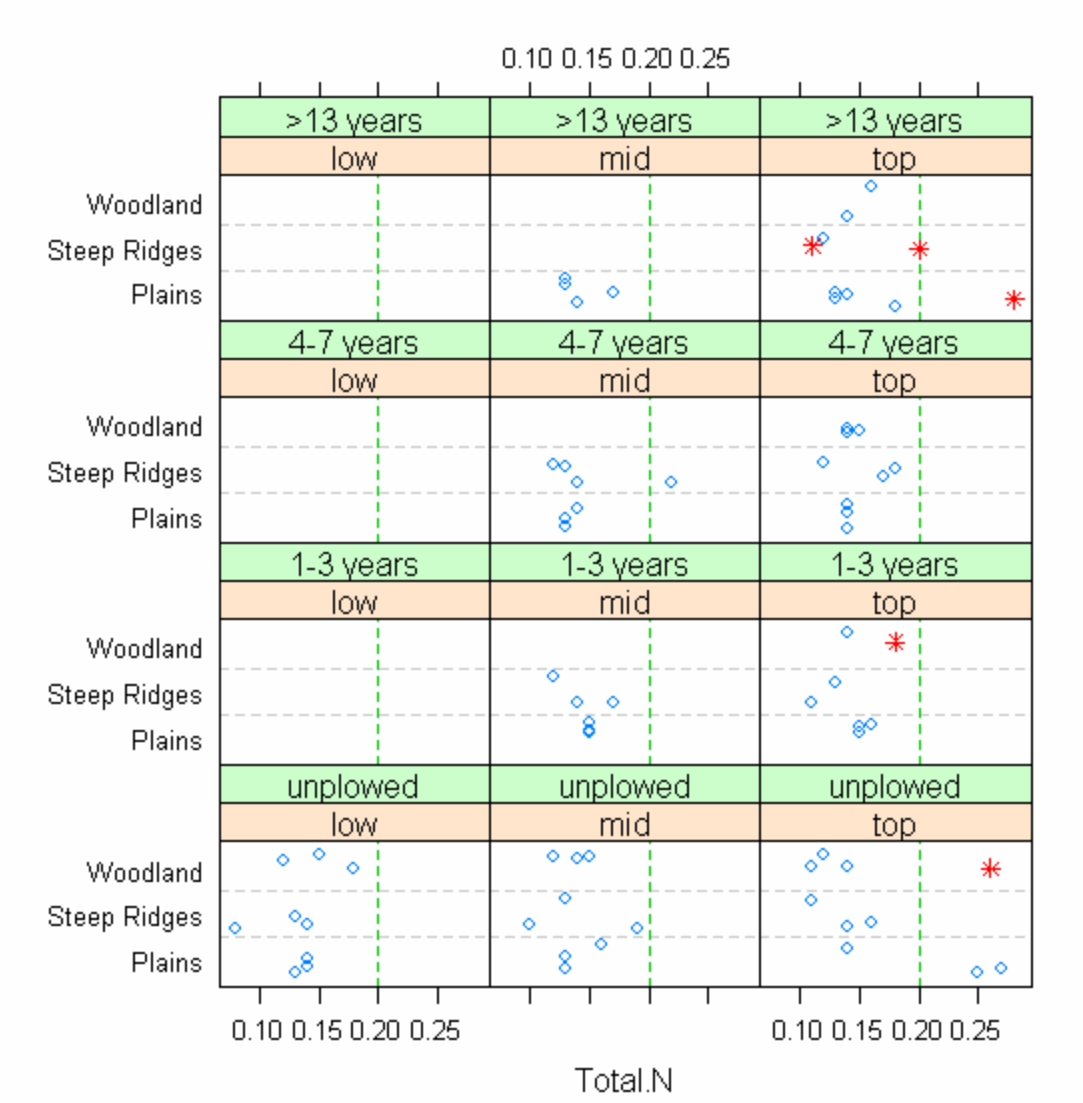


**Figure E.4** Percent total nitrogen in the soil samples, displayed by habitat, slope and age of field. The asterisks denote old boma sites. The green vertical line at 0.2 indicates the cutoff below which the soils are seriously nitrogen poor (Charman and Murphy 2000).

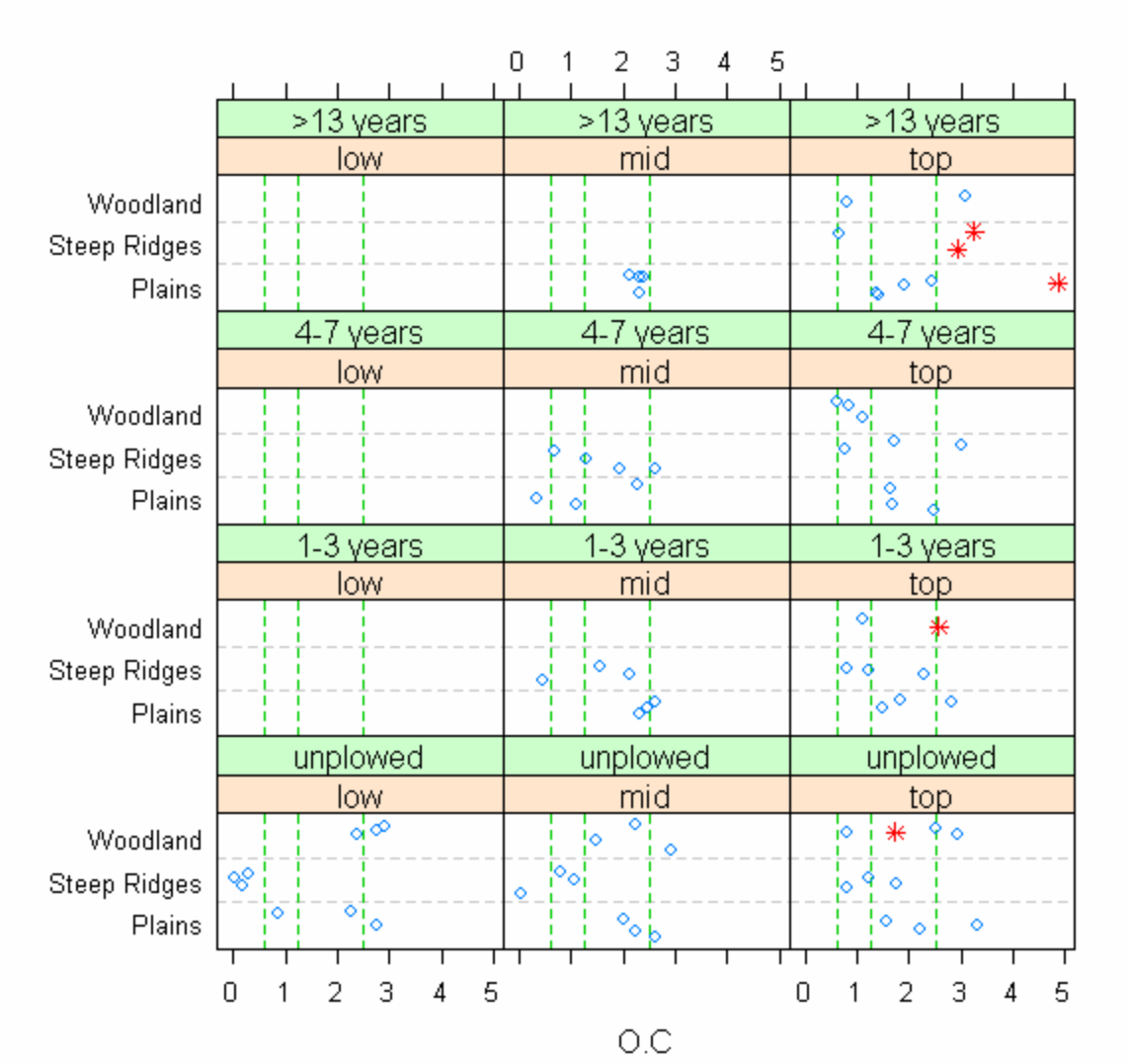


**Figure E.5** Percent organic carbon in the soil samples, displayed by habitat, slope and age of field. The asterisks denote old boma sites. The green vertical lines indicate cutoff points: <2.5% is low: 1.26-2.5 is medium, 0.6-1.25 is very low, <0.6 is unacceptable (Dr. Ramadhani Ngatoluwa, personal communication, April 2003).

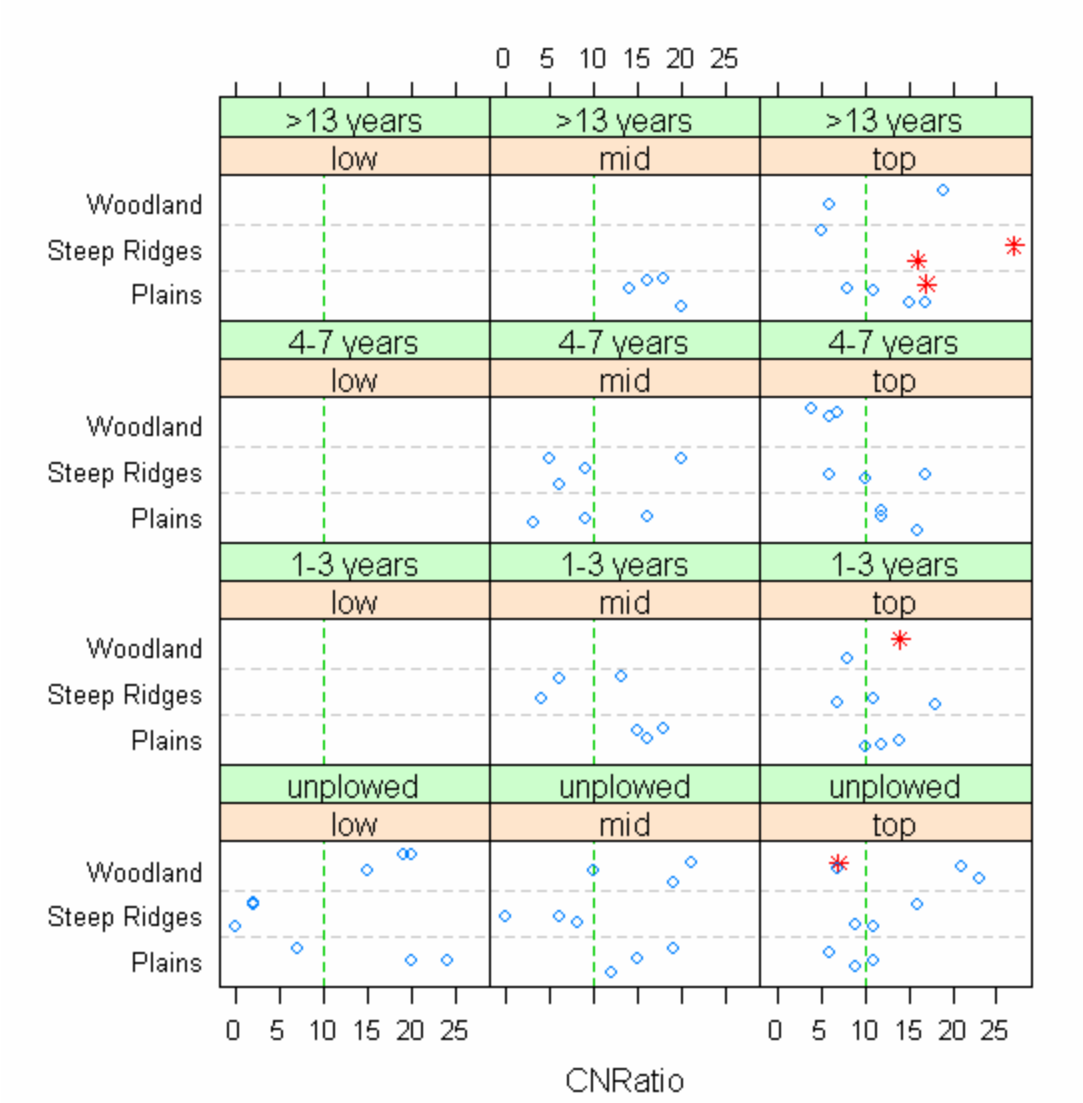


**Figure E.6** Ratio of organic carbon to total nitrogen in the soil samples, displayed by habitat, slope and age of field. The asterisks denote old boma sites. The green vertical line at 10 indicates the normal ratio for soils in Northern Tanzania (Dr. Ramadhani Ngatoluwa, personal communication, April 2003).

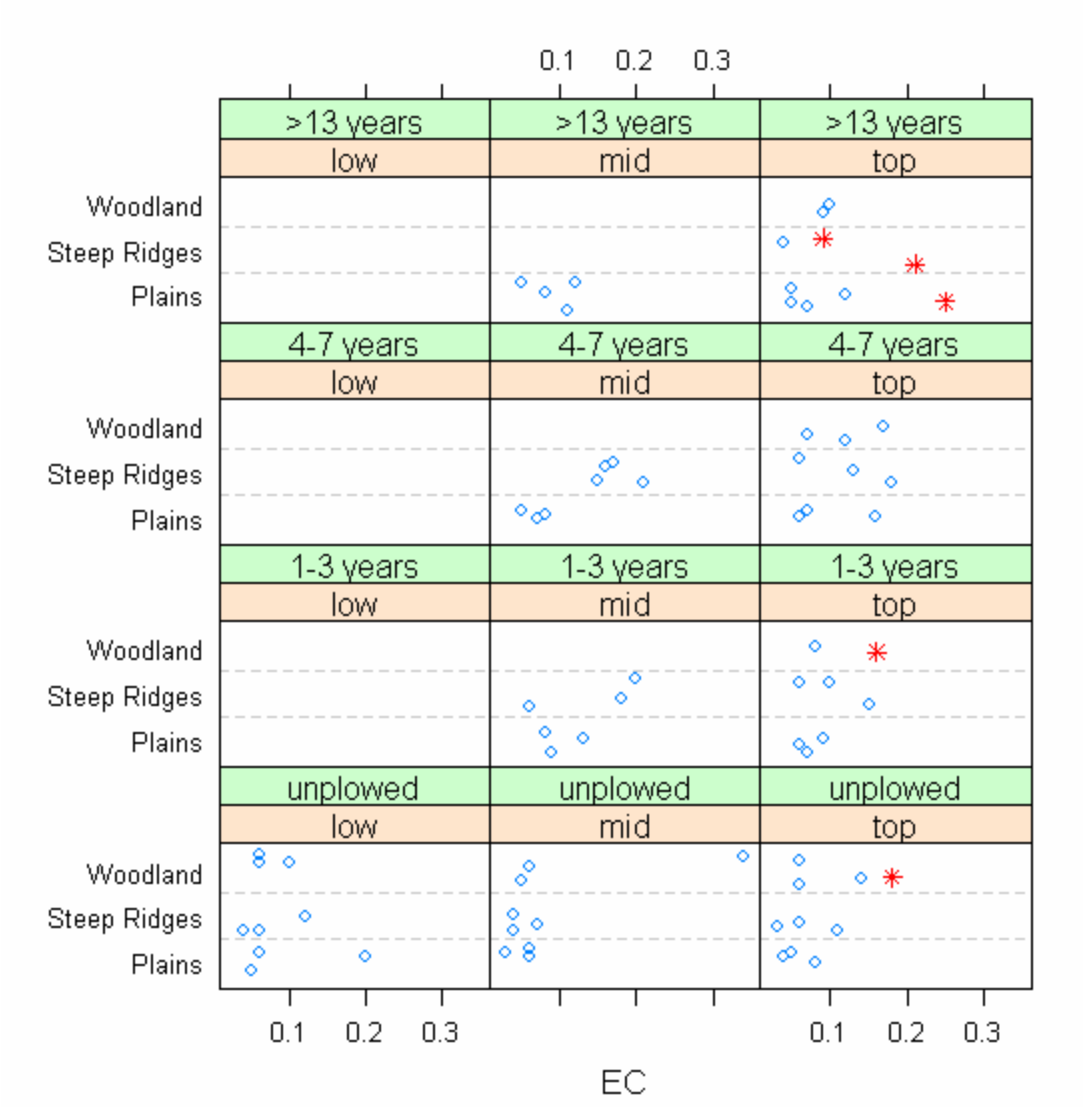


**Figure E.7** Measure of electrical conductivity in the soil samples (mS/cm), displayed by habitat, slope and age of field. The asterisks denote old boma sites. High EC (>4 mS/cm) indicates soils high in salt.

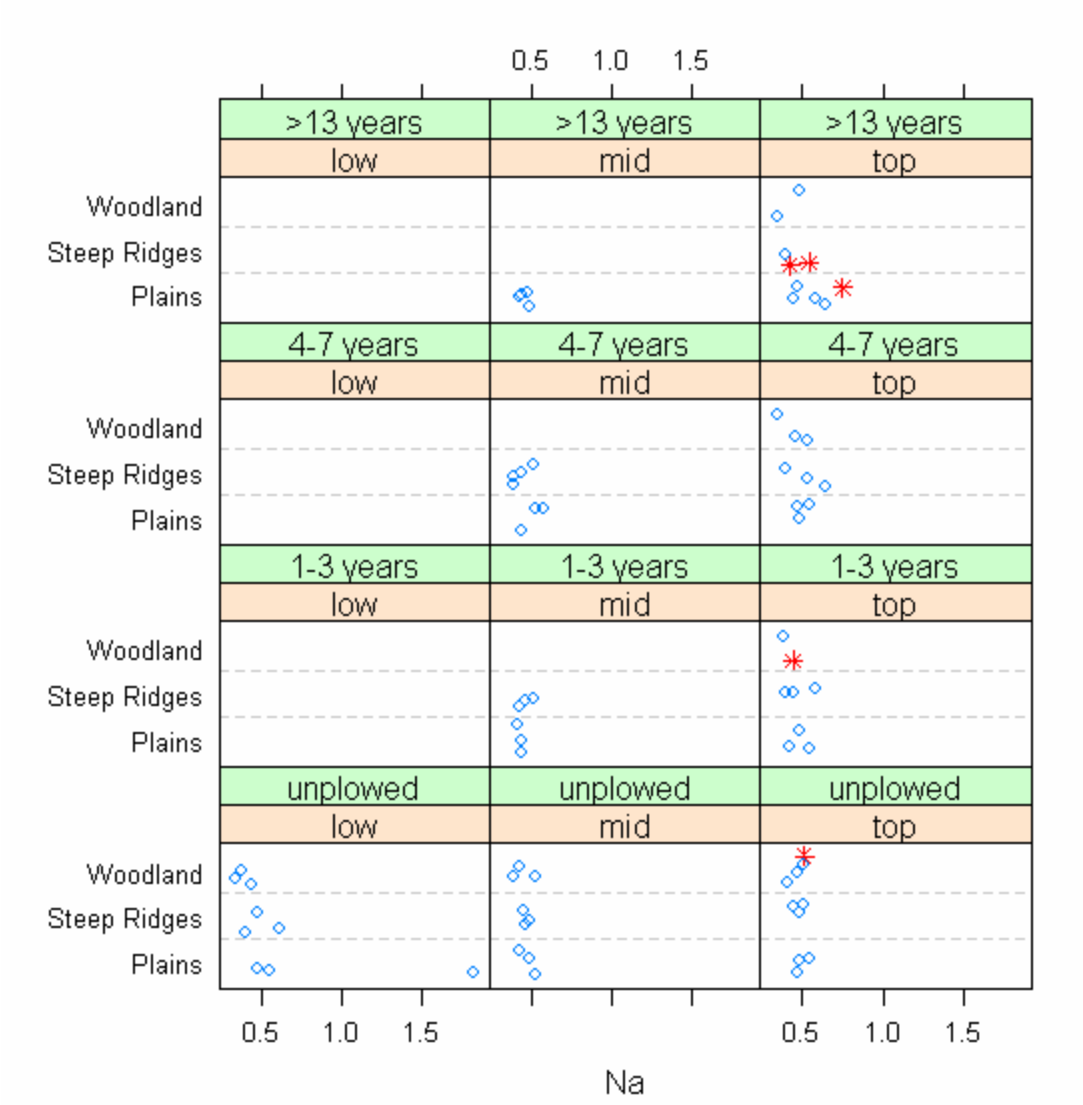


**Figure E.8** Sodium cations (cmol/kg) in the soil samples (mS/cm), displayed by habitat, slope and age of field. The asterisks denote old boma sites. The Loiborsoit soils were mostly low in sodium—good for growing crops but a problem for livestock. The one sample high in sodium (Plains/unplowed/lower slope) was a black soil near an *enguser,* a very salty black cotton soil (see Chapters 3 and 4).

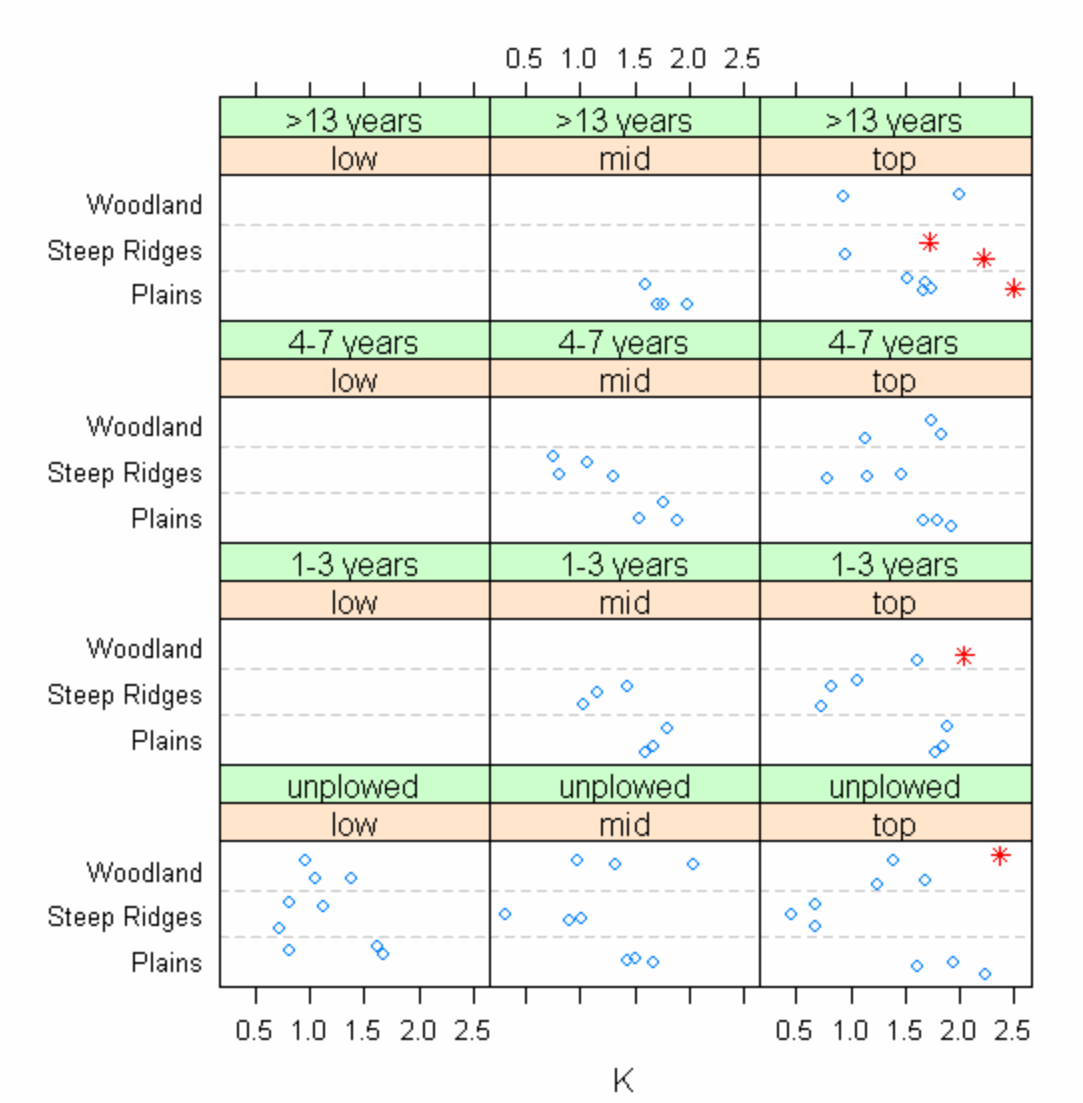


**Figure E.9** Potassium cations (cmol/kg) in the soil samples (mS/cm), displayed by habitat, slope and age of field. The asterisks denote old boma sites. The critical level for potassium is 0.1 Cmol/kg, which is reached by all samples.

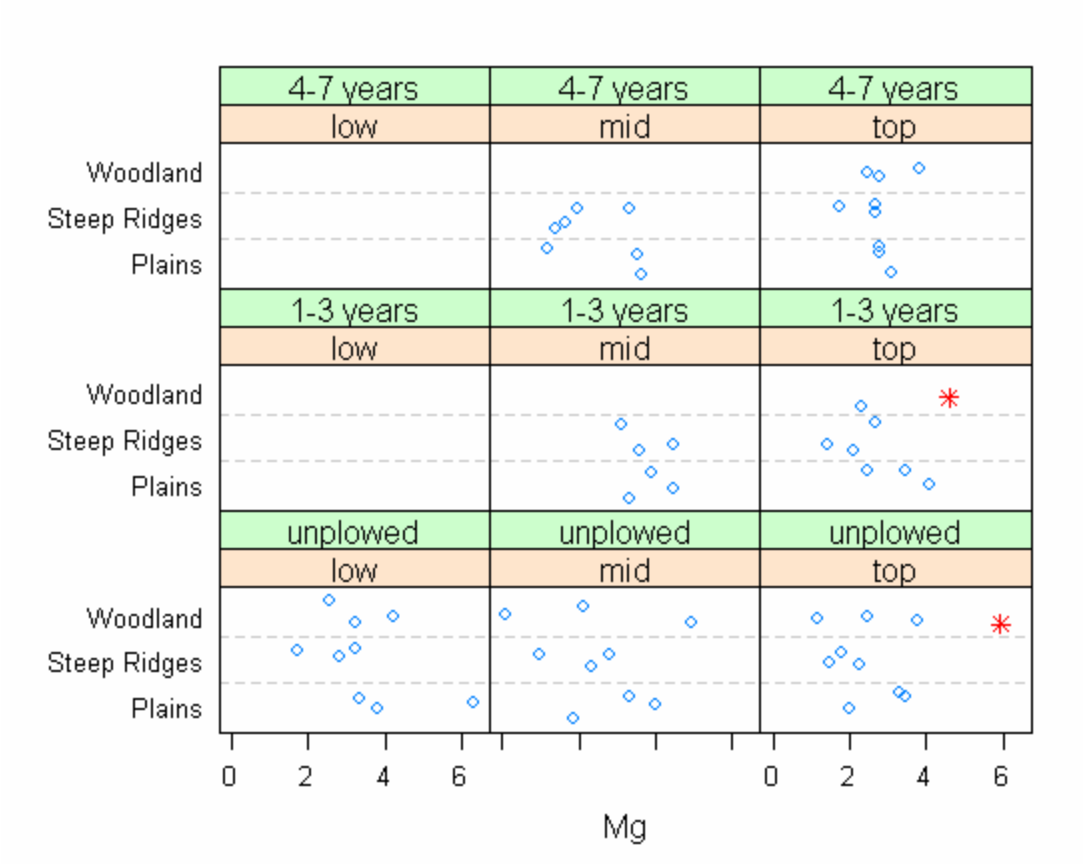


**Figure E.10** Magnesium cations (cmol/kg) in the soil samples (mS/cm), displayed by habitat, slope and age of field. The asterisks denote old boma sites.

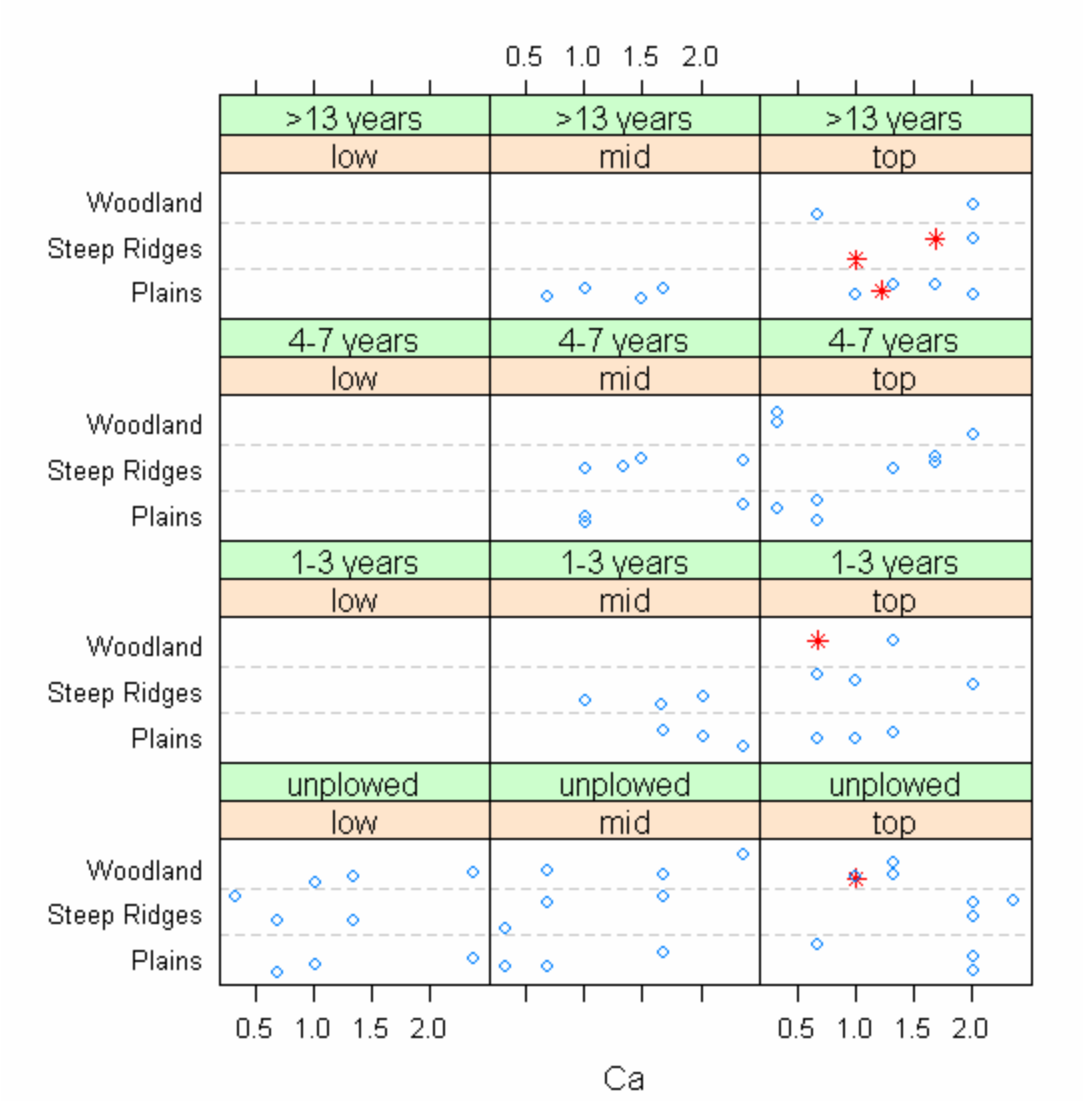


**Figure E.11** Calcium cations (cmol/kg) in the soil samples (mS/cm), displayed by habitat, slope and age of field. The asterisks denote old boma sites. According to Dr. Ngatoluwa of the Selian Agricultural Research Center in Arusha, these samples are low in calcium compared with the high potential areas around Arusha.

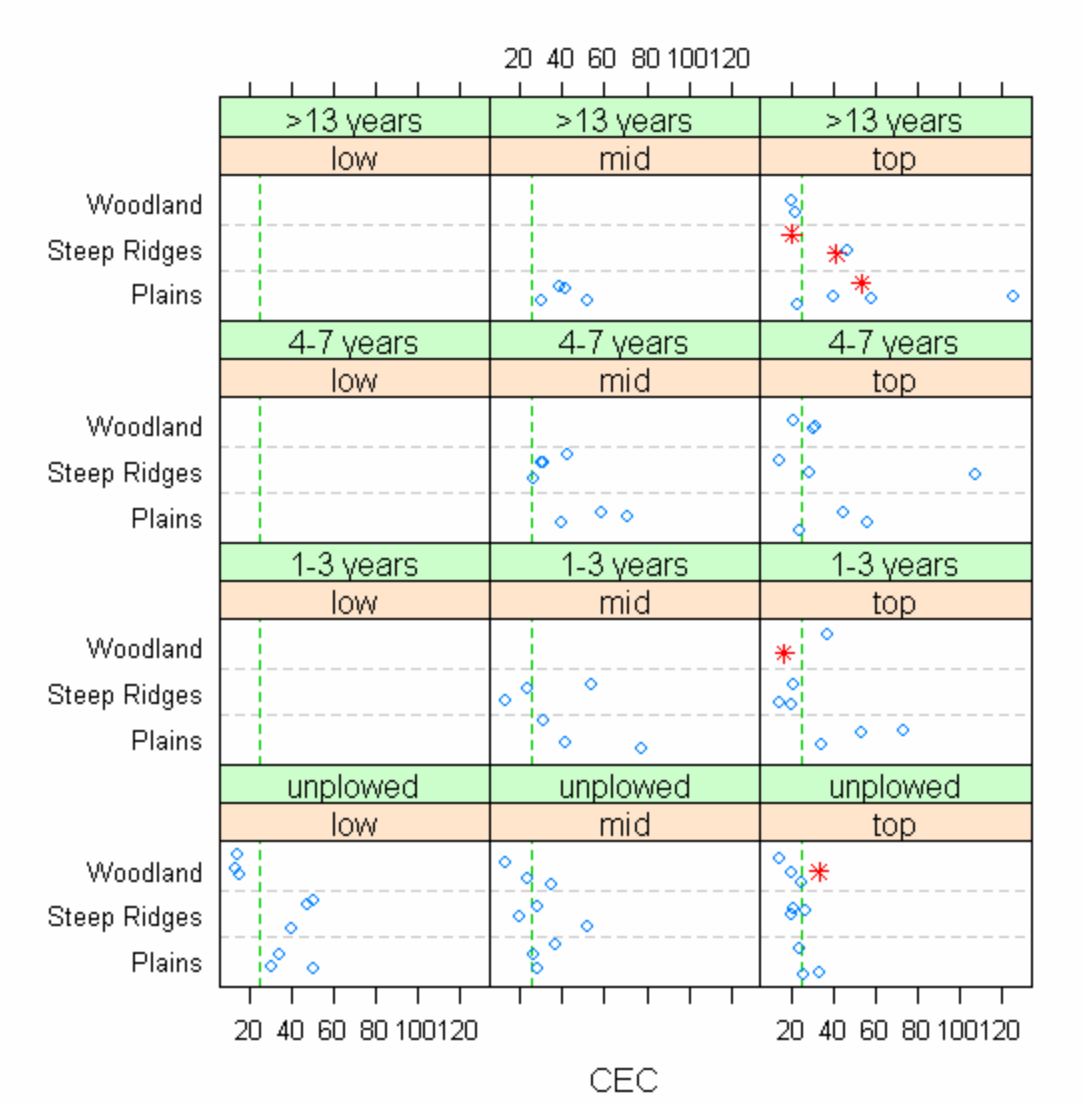


**Figure E.12** Cation exchange capacity (cmol/kg) in the soil samples (mS/cm), displayed by habitat, slope and age of field. The asterisks denote old boma sites. The green vertical line indicates the point at which CEC is considered to be very high.

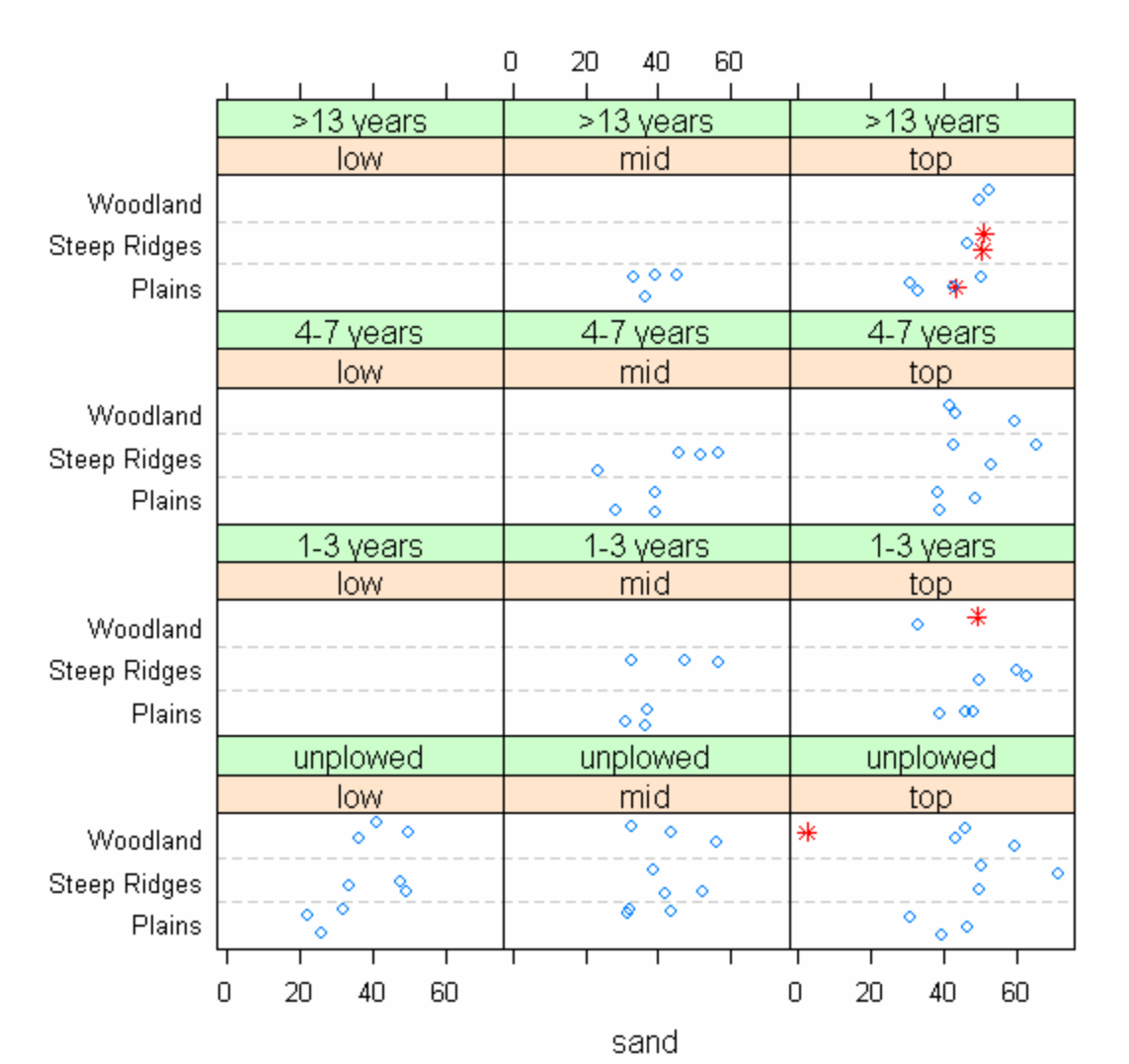


**Figure E.13** Proportion of sand particles in the soil samples (%), displayed by habitat, slope and age of field. The asterisks denote old boma sites.

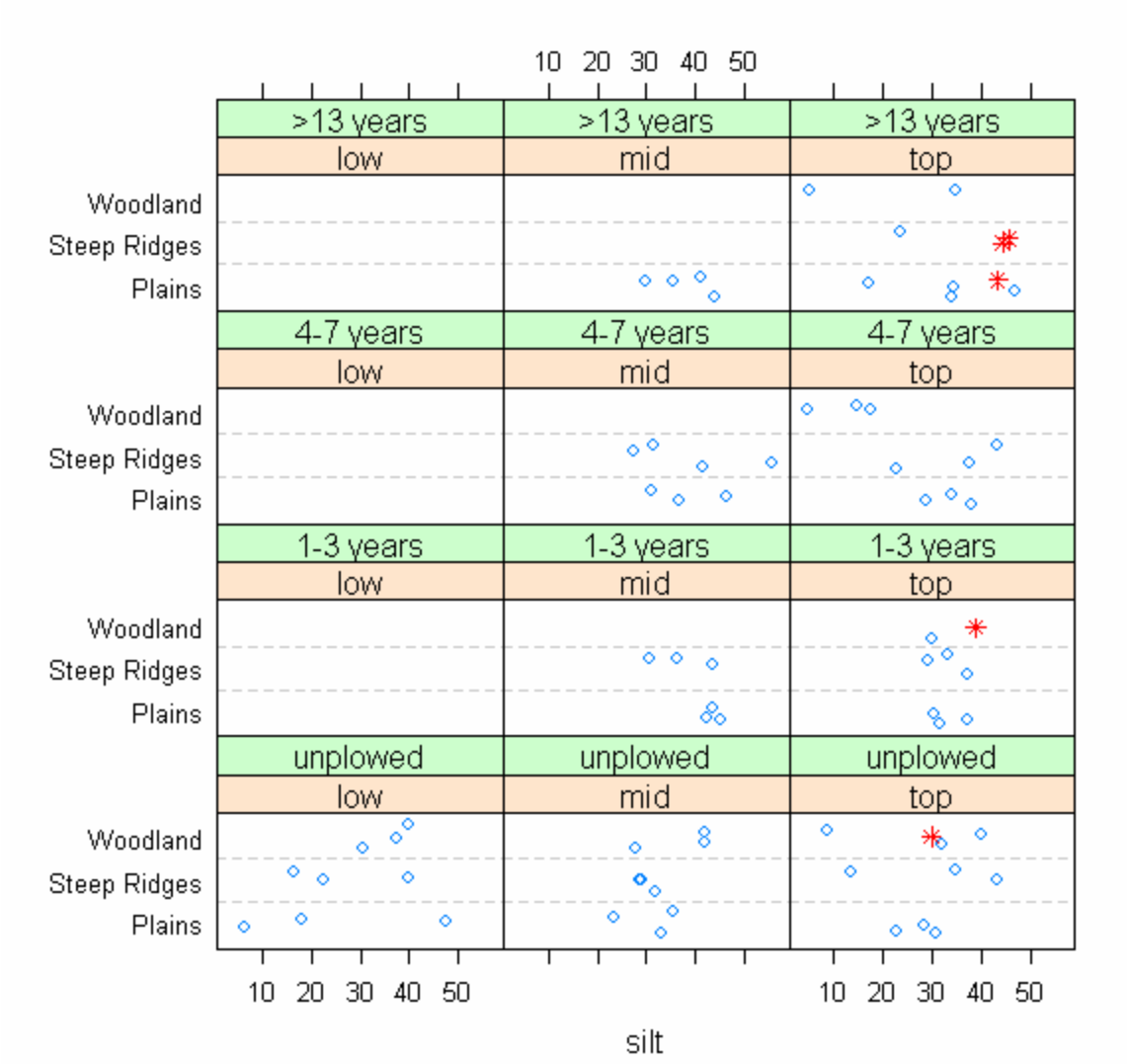


**Figure E.14** Proportion of silt particles in the soil samples (%), displayed by habitat, slope and age of field. The asterisks denote old boma sites.

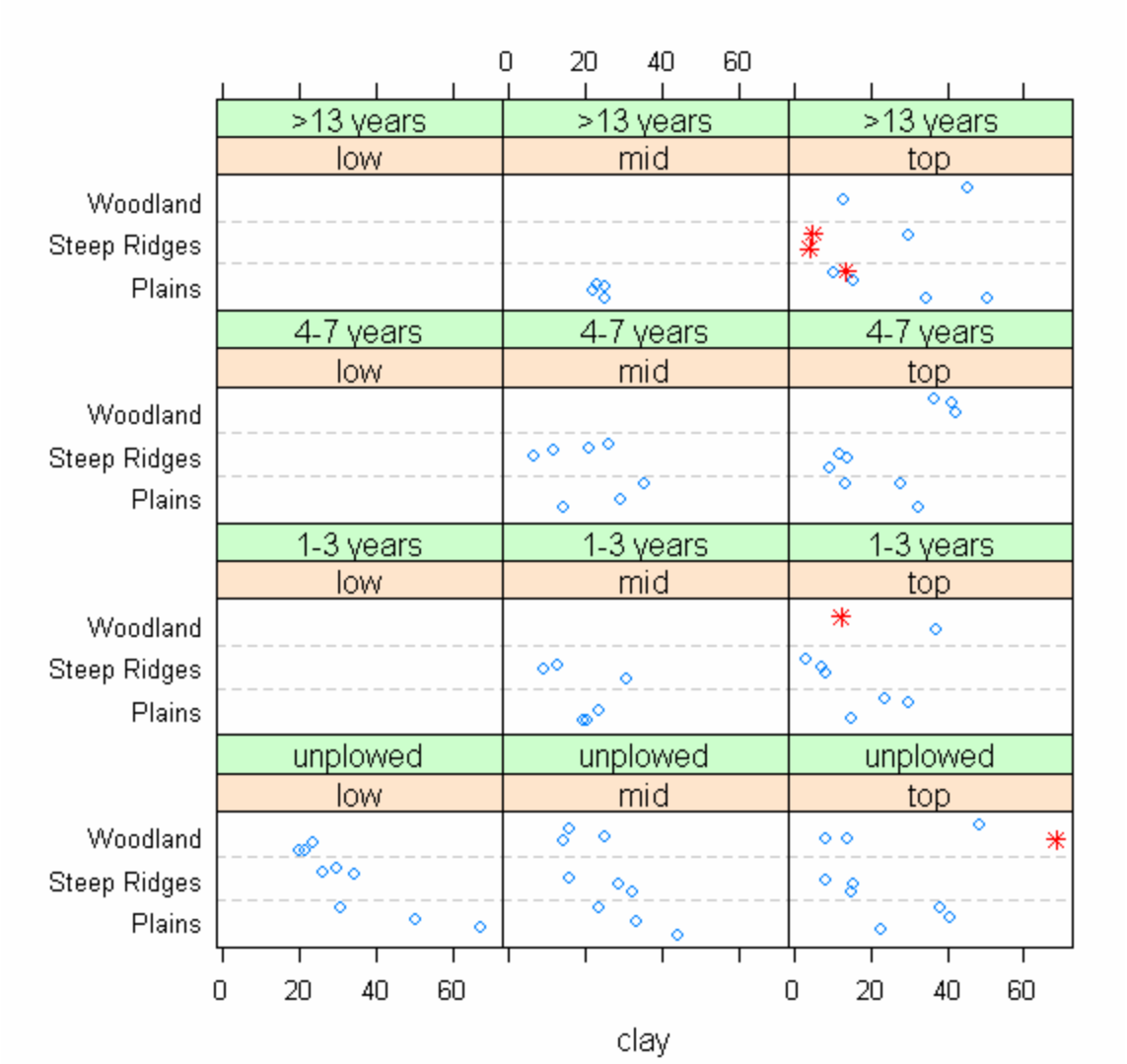


**Figure E.15** Proportion of clay particles in the soil samples (%), displayed by habitat, slope and age of field. The asterisks denote old boma sites.

## APPENDIX F

PARTIAL LIST OF SIMANJIRO FAUNA

| Common Name | Genus | species | |
|---|---|---|---|
| **Herbivores** | | | |
| Warthog | *Phacochoerus* | *africanus* | |
| Common Duiker | *Sylvicapra* | *grimmia* | |
| Impala | *Aepyceros* | *melampus* | |
| Coke's Hartebeest | *Alcelaphus* | *buselaphus* | *cokii* |
| Wildebeest | *Connochaetes* | *taurinus* | |
| Plains Zebra | *Equus* | *burchellii* | |
| Grant's gazelle | *Gazella* | *Granti* | |
| Thomson's gazelle | *Gazella* | *thomsonii* | |
| Giraffe, Masai. | *Giraffa* | *camelopardalis* | |
| Porcupine | *Hystrix* | *cristata* | |
| Hare | *Lepus* | *spp.* | |
| African Elephant | *Loxodanta* | *africana* | |
| Klipspringer? | *Oreotragus* | *oreotragus* | |
| Aardvark | *Orycteropus* | *afer* | |
| Oryx | *Oryx* | *gazella* | |
| Spring Hare | *Pedetes* | *capensis* | |
| Rock Hyrax | *Provavia* | *capensis* | |
| Steenbok | *Raphicerus* | *campestris* | |
| Reedbuck | *Redunca* | *arundinum* | |
| Bohor Reedbuck | *Redunca* | *redunca* | |
| Cape Buffalo | *Syncerus* | *caffer* | |
| Pangolin | *Temminck's* | *Pangolin* | |
| Lesser kudu | *Tragelaphus* | *imberis* | |
| Common Eland | *Tragelaphus* | *oryx* | |
| Bushbuck | *Tragelaphus* | *scriptus* | |
| Greater kudu | *Tragelaphus* | *strepsiceros* | |
| | | | |
| **Predators** | | | |
| Spotted Hyena | *Crocuta* | *crocuta* | |
| Jackal, silver-backed | *Canis* | *mesomelas* | |
| Jackal, side-striped | *Canis* | *adustus* | |
| African Wild dog | *Lycaon* | *pictus* | |
| Dwarf mongoose | *Mungos* | *mungo* | |
| Banded mongoose | *Helogale* | *parvula* | |

| | | | |
|---|---|---|---|
| White tailed mongoose | *Ichneumia* | *albicauda* | |
| Aardwolf | *Proteles* | *cristatus* | |
| African Wildcat | *Felis* | *libyca* | |
| Cheetah | *Acinonyx* | *jubatus* | |
| Bat-eared Foxes | *Otocyon* | *megalotis* | |
| Ratel (Badger) | *Mellivora* | *capensis* | |
| Leopard | *Panthere* | *pardus* | |
| Aardvark | *Orycteropus* | *afer* | |
| African civet | *Civettictis* | *civetta* | |
| Genet, common | *Genatta* | *genatta* | |
| Serval | *Felis (Leptailurus)* | *serval* | |
| Caracal | *Felis (Caracal)* | *caracal* | |
| Pangolin | *Manis* | *temminckii* | |
| Lion | *Panthera* | *leo* | |
| Zorilla | *Ictonyx* | *striatus* | |

**Primates**

| | | | |
|---|---|---|---|
| Vervet monkey | *Cercopithecus* | *aethiops* | |
| Savanna Baboons | *Papio* | *cynocephalus* | |
| Thick-tailed bushbaby | *Galago* | *crassicaudatus* | |
| Lesser bushbaby | *Galago* | *senagalensis* | |

**Birds**

| | | | |
|---|---|---|---|
| Ostrich, Masai race | *Struthio* | *camelus* | |
| Egyptian goose | *Alopochen* | *aegyptiacus* | |
| Great egret | *Casmerodius* | *albus* | |
| Cattle egret | *Bubulcus* | *intermedia* | *maasicus* |
| Hammerkop | *Scopus* | *u. umbretta* | |
| Yellow-billed stork | *Mycteria* | *ibis* | *melanorhynchos* |
| White stork | *Ciconia* | *c. ciconia* | *ibis* |
| Abdim's Stork | *Ciconia* | *abdimii* | |
| Marabou Stork | *Leptoptilus* | *crumeniferus* | |
| Secretary bird | *Sagittarius* | *serpentarius* | |
| Kori Bustard | *Ardeotis* | *kori* | |
| Fischer's Lovebirds | | | |
| Southern Ground-Hornbill | *Bucorvus* | *leadbeateri* | |
| Black stork | *Ciconia* | *nigra* | *struthiunculus* |
| Grey crowned crane | *Balearica* | *regulorum* | |
| Hadada ibis | *Bostrychia* | *hagedash* | |
| Sacred ibis | *Threskiornis* | *alba* | |
| Black-headed heron | *Ardea* | *melanocephala* | *gibbericeps* |

| | | | |
|---|---|---|---|
| Spur-winged goose | *Plectropterus* | *g.* | *brevirostris* |
| Knob-billed duck | *Sarkidiornis* | *m.* | *aethiopicus* |
| Hottentot teal | *Anas* | *hottentota* | |
| Red-billed teak | *Anas* | *erythrorhyncha* | *gambensis* |
| Southern pochard | *Netta* | *erythrophthalma* | *melanotos* |
| Temminck's courser | *Cursorius* | *temminckii* | |
| Crowned plover | *Vanellus* | *c.* | |
| Blacksmith plover | *Vanellus* | *armatus* | *brunnea* |
| Black-headed plover | *Vanellus* | *tectus* | |
| Crested francolin | *Francolinus* | *sephaena* | *coronatus* |
| Hildebrandt's francolin | *Francolinus* | *hildebrandti* | |
| Coqui francolin | *Francolinus* | *coqui* | |
| Common quail | *Coturnix* | *coturnix* | |
| Harlequin quail | *Coturnix* | *d.* | |
| Shelley's francolin | *Francolinus* | *shelleyi* | |
| Yellow-necked spurfowl | *Francolinus* | *leucoscepus* | *erlangeri* |
| Helmeted guineafowl | *Numida* | *meleagris* | *delegorguei* |
| Lappet-faced vulture | *Torgos* | *t.* | *uluensis* |
| Bateleur | *Terathopius* | *ecaudatus* | |
| Steppe eagle | *Aquila* | *nipalensis* | |
| Tawny eagle | *Aquila* | *r.* | *tracheliotus* |
| Ayres's hawk-eagle | *Hieraaetus* | *ayresii* | |
| Little sparrowhawk | *Accipiter* | *m.* | *orientalis* |
| Imperial eagle | *Aquila* | *heliaca* | *rapax* |
| Tawny eagle | *Aquila* | *r.* | |
| Martial eagle | *Polemaetus* | *bellicosus* | *minullus* |
| Augur buzzard | *Buteo* | *a.* | |
| Egyptian vulture | *Neophron* | *p.* | *rapax* |
| Ruppell's grifon vulture | *Gyps* | *r.* | |
| African white-backed vulture | *Gyps* | *africanus* | *augur* |
| Spotted thick-knee | *Burhinus* | *capensis* | *percnopterus* |
| Verreaux's eagle | *Aquila* | *verreauxii* | *rueppellii* |
| Long-crested eagle | *Lophaetus* | *occipitalis* | |
| Lizzard buzzard | *Kaupifalco* | *m.* | |
| African harrier-hawk | *Polyboroides* | *t.* | |
| Gabar groshawk | *Micronisus* | *gabar* | |
| Eurasian marsh-harrier | *Circus* | *a.* | *monogrammicus* |
| Montagu's harrier | *Circus* | *pygargus* | *typus* |
| Pallid harrier | *Circus* | *macrourus* | *aequitorius* |
| Shikra | *Accipiter* | *badius* | *aeruginosus* |
| Black-shouldered kite | *Elanus* | *c.* | |

| | | | |
|---|---|---|---|
| Lesser spotted eagle | *Aquila* | *p.* | |
| Common (steppe) buzzard | *Buteo* | *buteo* | *sphenurus* |
| Brown snake eagle | *Circaetus* | *cinereus* | *caeruleus* |
| Eastern pale chanting goshawk | *Melierax* | *poliopterus* | *pomarina* |
| Great sparrowhawk | *Accipiter* | *m.* | *vulpinus* |
| African hawk-eagle | *Hieraaetus* | *spilogaster* | |
| Black kite | *Milvus* | *m.* | |
| Pygmy falcon | *Polihierax* | *semitorquatus* | *melanoleucus* |
| African orange-bellied parrot | *Poicephalus* | *r.* | |
| Fischer's lovebird | *Agapornis* | *fischeri* | *migrans* |
| Yellow-collared lovebird | *Agapornis* | *persontus* | *castanonotus* |
| Yellow-throated sandgrouse | *Pterocles* | *gutturalis* | *rufiventris* |
| Laughing dove | *Streptopelia* | *s.* | |
| Ring-necked dove | *Streptopelia* | *capicola* | |
| Red-eyed dove | *Streptopelia* | *semitorquata* | *saturatior* |
| African green pigeon | *Treron* | *calva* | *senegalensis* |
| Rock dove | *Columba* | *livia* | *somalica* |
| Speckled pigeon | *Columba* | *g.* | |
| Namaqua dove | *Oena* | *c.* | *givverifrons* |
| White bellied go-away bird | *Criniferoides* | *leucogaster* | |
| Bare-faced go-away bird | *Corythaixoides* | *personata* | *guinea* |
| Klaas's cuckoo | *Chrysococcyx* | *klaas* | *capensis* |
| Great spotted cuckoo | *Clamator* | *glandarius* | |
| Short-eared owl | *Asio* | *c.* | *leopoldi* |
| African grass owl | *Tyto* | *capensis* | |
| Barn owl | *Tyto* | *alba* | |
| African wood owl | *Strix* | *woodfordii* | *capensis* |
| Spotted eagle-owl | *Bubo* | *african* | |
| Verreaux's eagle-owl | *Bubo* | *lacteus* | *affinis* |
| Blue-naped mousebird | *Urocolius* | *macrourus* | *nigricantior* |
| Speckled mousebird | *Colius* | *striatus* | |
| Striped kingfisher | *Halcyon* | *c.* | |
| Little bee-eater | *Merops* | *pusillus* | *pulcher* |
| Cinnamon-chested bee-eater | *Merops* | *oreobates* | *kikuyuensis* |
| Lilac-breasted roller | *Coracias* | *caudata* | *chelicuti* |
| Hoopoe | *Upupa* | *epops* | *cyanostictus* |
| Green wood-hoopoe | *Phoeniculus* | *purpureus* | |
| Jackson's hornbill | *Tockus* | *jacksoni* | |
| Von der decken's hornbill | *Tockus* | *deckeni* | |
| Red-billed hornbill | *Tockus* | *e.* | |
| African grey hornbill | *Tockus* | *nasutus* | |

| | | | |
|---|---|---|---|
| Red-fronted barbet | *Tricholaema* | *diademata* | |
| Red-and-yellow barbet | *Trachyphonus* | *erythrocephalus* | *erythrorhynchus* |
| Speckle-breasted woodpecker | *Dendropicos* | *poecilolaemus* | |
| Pallid honeyguide | *Indicator* | *meliphilus* | |
| African pied wagtail | *Motacilla* | *capensis* | |
| Flappet lark | *Mirafra* | *rufocinnamomea* | |
| Mosque swallow | *Hirundo* | *spp.* | |

## LITERATURE CITED


Anderson D. 2002. *Eroding the commons: the politics of ecology in Baringo, Kenya, 1890s-1963.* James Currey, Oxford.

Anderson D. and V. Broch-Due. 1999. *The poor are not us: poverty & pastoralism in Eastern Africa*. J. Curry, Oxford.

Anderson, D. and R. Grove. 1987. *Conservation in Africa: people, policies, and practice.* Cambridge University Press, New York.

Århem, K. 1985. *Pastoral man in the garden of Eden.* University of Uppsala and the Scandinavian Institute of African Studies, Uppsala.

Augustine, D. J. 2003. Long-term, livestock-mediated redistribution of nitrogen and phosphorus in an East African savanna. *Journal of Applied Ecology* 40:137-149.

AWF. 2006. Putting the landscape back together in Maasai Steppe. *African Heartland News,* p1-5.

Balee, W. and C. L. Erickson. 2006. Time, complexity and historical ecology. In *Time and complexity in historical ecology: studies in the Neotropical lowlands*, W. Balee and C. L. Erickson, editors. Columbia Press University, New York. Pp 1-12

Banks, T. 2001. Property Rights and the Environment in Pastoral China: Evidence from the Field. *Development and Change* 32:717-740.

Becker, M. J. 2004. Maya heterarchy as inferred from Classic-period plaza plans. *Ancient Mesoamerica* 15:127-138.

Behnke, R. H., I. Scoones, and C. Kerven. 1993. *Range ecology at disequlibrium: new models of natural variability and pastoral adaptation in African savannas*. International Institute for Environment and Development, London.

Beinart, W. 1984. Soil Erosion, Conservationism and Ideas about Development: A Southern African Exploration, 1900-1960. *Journal of Southern African Studies* 11:52-83.

Belsky, A. J. 1995. Spatial and temporal landscape patterns in arid and semi-arid African savannas. In L. Hansson, L. Fahrig, and G. Merriam (editors), *Mosaic landscapes and ecological processes*, pp 31-56. Chapman & Hall, London.

Berkes, F. 2004. Rethinking community-based conservation. *Conservation Biology* 18:621-630.

Berkes, F. and C. Folke. 1998. Linking social and ecological systems for resilience and sustainability. In F. Berkes and C. Folke (editors), *Linking Social and Ecological Systems*, pp 1-26. Cambridge University Press, Cambridge.

Blaikie, P. 1985. *The political economy of soil erosion in developing countries.* Longman, New York.

Blaikie, P. M. and H. C. Brookfield. 1987. *Land degradation and society.* Methuen, London; New York.

Borner, M. 1985. The increasing isolation of Tarangire National Park. *Oryx* 19:91-96.

Boserup, E. 1965. *The conditions of agricultural growth: the economics of agrarian change under population pressure.* Aldine Pub. Co., New York.

Boserup, E., T. P. Schultz. 1990. *Economic and demographic relationships in development*. Johns Hopkins University Press, Baltimore.

Brockington, D. 2002. *Fortress conservation: The preservation of the Mkomazi Game Reserve.* Indiana University Press, Bloomington.

Brockington, D. and K. Homewood. 1996. Wildlife, pastoralists and science: debates concerning Mkomazi Game Reserve, Tanzania. In M. Leach and R. Mearns (editors), *The Lie of the Land: Challenging Received Wisdom on the African Environment*, pp 91-104. James Currey, Oxford.

Brookfield, H. C. 1972. Intensification and disintensification in Pacific agriculture: A theoretical approach. *Pacific Viewpoint* 13:30-48.

Brookfield, H. C. 2001. *Exploring agrodiversity.* Columbia University Press, New York.

Brush, S. B. and B. L. Turner. 1987. The nature of farming systems and views of their change. In B. L. Turner and S. B. Brush (editors), *Comparative Farming Systems*, pp 11-48. The Guildford Press, New York.

Campbell, D. J. 1993. Land as Ours, Land as Mine: Economic, Political and Ecological Marginalization in Kajiado District. In T. Spear and R. Waller (editors), *Being Maasai*, pp 258-272. Ohio University Press, Athens, OH.

Campbell, D. J., H. Gichohi, A. Mwangi, and L. Chege. 2000. Land use conflict in Kajiado District, Kenya. *Land Use Policy* 17:337-348.

Cingolani, A. M., I. Noy-Meir, and S. Diaz. 2005. Grazing effects on rangeland diversity: A synthesis of contemporary models. *Ecological Applications* 15:757-773.

Charman, P. E. V. and B. W. Murphy. 2000. Soils, their properties and management. Oxford University Press, Oxford.

Conroy, A. B. 2001. *Maasai Oxen, Agriculture and Land Use Change in Monduli District, Tanzania.* PhD Dissertation, University of New Hampshire.

Coppock, D. L. 1994. *The Borana Plateau of Southern Ethiopia: Synthesis of pastoral research, development and change, 1980-91*. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia.

Costanza, R. 1996. Ecological economics: Reintegrating the study of humans and nature. *Ecological Applications* 6:978-990.

Cronon, W. 1983. *Changes in the land: Indians, colonists, and the ecology of New England.* Hill and Wang, New York.

Crosby, A. W. 2004. *Ecological Imperialism: the biological expansion of Europe, 900-1900.* Cambridge University Press,

Crumely, C. (ed). 1994. *Historical Ecology: Cultural Knowledge and Changing Landscapes.* School of American Research Press. Sante Fe, NM

Datoo, B. A. 1978. Toward a Reformulation of Boserup's Theory of Agricultural Change. *Economic Geography* 54:135-144.

Dejene, A., Shishira E.K., Yanda P.Z., Johnsen F.H. *Land Degradation in Tanzania*. World Bank; 1997.

Desta, S. and D. L. Coppock. 2004. Pastoralism under pressure: tracking system change in Southern Ethiopia. *Human Ecology* 32:465-486.

Dietz, T., E. Ostrom, and P. C. Stern. 2003. The struggle to govern the commons. *Science* 302:1907-1912.

Dolšak, N. and E. Ostrom. 2003. The challenges of the commons. In *The Commons in the New Millenium*, N. Dolšak and E. Ostrom, editors The MIT Press, Cambridge, MA. Pp 3-33.

Dublin, H. T. 1995. Vegetation dynamics in the Serengeti-Mara ecosystem: the role of elephants, fire, and other factors. In A.R.E. Sinclair and P. Arcese (editors) *Serengeti II: Dynamics, Management and Conservation of an Ecosystem*, Pp71-90. Chicago University Press, Chicago.

Ellis, J. E. and D. M. Swift. 1988. Stability of African pastoral ecosystems: Alternate paradigms and implications for development. *Journal of Range Management* 41:450-459.

Ford, J. 1971. *The role of the trypanosomiases in African ecology: A study of the tsetse fly problem*. Clarendon Press Oxford, United Kingdom.

Foster, D., F. Swansom, J. Aber, I. Burke, N. Brokaw, D. Tilman, and A. Knapp. The importance of land-use legacies to ecology and conservation. *Bioscience* 53:77-88.

Fratkin, E. M. 1994. *Problems of pastoral land tenure in Kenya: demographic, economic and political processes among Maasai, Samburu, Boran, and Rendille 1950-1990*. African Studies Center, Boston University, Boston, MA.

Fratkin, E. 1997. Pastoralism: Governance and development issues. *Annual Review of Anthropology* 26:235-261.

Fratkin, E. 2001. East African pastoralism in transition: Maasai, Boran, and Rendille Cases. *African Studies Review* 44:1-25.

Fratkin, E. and R. Mearns. 2003. Sustainability and pastoral livelihoods: Lessons from East African Maasai and Mongolia toward an anthropological understanding of sustainability. *Human organization* 62:112-122.

Galaty, J. G. 1993a. 'The eye that wants a person, where can it not see?': inclusion, exclusion and boundary shifters in Maasai identity. In T. Spear and R. Waller (editors), *Being Maasai*, pp 174-194. Ohio University Press, Athens, OH.

Galaty, J. G. 1993b. Maasai expansion and the new East African pastoralism. In T. Spear and R. Waller (editors), *Being Maasai,* pp 61-86. Ohio University Press, Athens, OH.

Gamassa, D.G.M. 1989. *Land use conflicts in arid areas: a demographical and ecological case study: the Kwakuchinja wildlife corridor in Northern Tanzania.* Thesis: Agricultural University of Norway.

Gamassa, D. 1996. The pastoral Maasai and wildlife conservation in Tanzania. *Nature Conservation* 4:107–111.

Gereta, E., G. E. Ole Meing'ataki, S. Mduma, and E. Wolanski. 2004. The role of wetlands in wildlife migration in the Tarangire ecosystem, Tanzania. *Wetlands Ecology and Management* 12:285-299.

Goldman, M. 2003. Partitioned Nature, Privileged Knowledge: Community-based Conservation in Tanzania. *Development and Change* 34:833-862.

Hardin, G. 1968. The tragedy of the commons. *Science* 162:1243-1248.

Hardin, G. 1994. The tragedy of the unmanaged commons. *Trends in Ecology and Evolution* 9:199.

Hathout, S. A. 1983. *Soil atlas of Tanzania*. Tanzania Publishing House, Dar es Salaam.

Hoben, A. 1976. A. *Social soundness of the Masai livestock and range management program*. Dar es Salaam: USAID Mission.

Hodgson, D. 2001. *Once intrepid warriors: gender, ethnicity, and the cultural politics of Maasai development.* Indiana University Press, Bloomington.

Hodgson, D., R. A. Schroeder. 2002. Dilemmas of counter-mapping community resources in Tanzania. *Development and Change* 33:79-100.

Holling, C. S., L. H. Gunderson. 2002. Resilience and adaptive cycles. In C. S. Holling and L. H. Gunderson (editors), *Panarchy: Understanding transformations in human and natural systems,* (pp 25-62). Island Press.

Homewood, K. 1995. Development, Demarcation and Ecological Outcomes in Maasailand, Africa. *Journal of the International African Institute* 65:331-350.

Homewood, K. M. 2004. Policy, environment and development in African rangelands. *Environmental Science and Policy* 7:125-143.

Homewood, K., D. Brockington. 1999. Biodiversity, conservation and development in Mkomazi Game Reserve, Tanzania. *Global Ecology and Biogeography* 8:301-313.

Homewood, K., E. F. Lambin, E. Coast, A. Kariuki, I. Kikula, J. Kivelia, M. Said, S. Serneels, and M. Thompson. 2001. Long-term changes in Serengeti-Mara wildebeest and land cover: Pastoralism, population, or policies? *Proceedings of the National Academy of Sciences* 98:12544-12549.

Homewood, K. M., W. A. Rodgers. 1991. *Maasailand ecology. Pastoralist development and wildlife conservation in Ngorongoro, Tanzania.* Cambridge University Press, New York, NY.

Igoe, J. 1999. *Roadblocks to community conservation in Tanzania: a case study from Simanjiro district*. African Studies Center, Boston University, Boston, MA.

Igoe, J. 2004. *Conservation and globalization: a study of national parks and indigenous communities from East Africa to South Dakota.* Thomson/Wadsworth, Australia; Belmont, CA.

Igoe, J. and D. Brockington. 1999. *Pastoral Land Tenure and Community Conservation: A Case Study from North-East Tanzania.* International Institute for Environment and Development. London.

Illius, A. W., T. G. O'Connor. 1999. On the relevance of nonequilibrium concepts to arid and semiarid grazing systems. *Ecological Applications* 9:798-813.

Jacobs, A. H. 1965. *The Traditional Political Organization of the Pastoral Masai*. PhD Dissertation, University of Oxford.

Jennings, C. 2005. Beyond eponymy: the evidence for Loikop as an ethnonym in nineteenth-century East Africa. *History in Africa* 32:199-220.

Kabubo-Mariara, J. 2005. Herders response to acute land pressure under changing property rights: some insights from Kajiado District, Kenya. Environment and *Development Economics* 10:67-85.

Kahurananga, J. 1976. *The ecology of large herbivores in Simanjiro Plains, Northern Tanzania.* PhD Dissertation, University of Nairobi, Kenya.

Kahurananga, J. 1979. The vegetation of the Simanjiro Plains, Northern Tanzania. *African Journal of Ecology* 17:65-83.

Kideghesho, J. R., N. Shombe-Hassan, and J. Porokwa. 2000. Can Tarangire survive? *Kakakuona: Tanzania wildlife magazine* 18:10-17.

Kikula, I. S. 1997. *Policy Implications on Environment: the case of villagisation in Tanzania.* Nordic Africa Institute, Uppsala.

Lama, L. 1998. *Conflict and compatibility: an inventory and analysis of land use in a Tanzanian wildlife corridor.* PhD Dissertation, State University of New York, Binghamton.

Lamphear, J. 1993. Aspects of 'becoming Turkana': interactions and assimilation between Maa- and Ateker- speakers. In T. Spear and R. Waller, (editors), *Being Maasai*, pages 87-104. Ohio University Press, Athens, OH.

Lamprey, H. F. 1963. The Tarangire Game Reserve. *Tanganyika Notes and Records* 60:10-22.

Lamprey, R. H., R. S. Reid. 2004. Expansion of human settlement in Kenya's Maasai Mara: what future for pastoralism and wildlife? Journal of Biogeography 31:997-1032.

Lane, C. R. 1998. Introduction. In C. R. Lane (editor), *Custodians of the commons: Pastoral land tenure in East and West Africa*, pp 1-25. Earthscan Publications Ltd, London.

Lane, C. R., R. Moorehead. 1994. *Who should own the range? New thinking on pastoral resource tenure in drylands Africa.* International Institute for Environment and Development, Drylands Programme, London.

Limpert, E., W. A. Stahel, and M. Abbt. 2001. Log-normal Distributions across the Sciences: Keys and Clues. *Bioscience* 51:341-352.

Little, M. A. and P. W. Leslie. 1999. *Turkana herders of the dry savanna: ecology and biobehavioral response of nomads to an uncertain environment.* Oxford University Press, Oxford; New York.

Little, P. D., K. Smith, B. A. Cellarius, D. L. Coppock, and C. B. Barrett. 2001. Avoiding Disaster: Diversification and Risk Management among East African Herders. *Development and Change* 32:401-433.

Lovett, J. C., C. H. Quinn, D. G. Ockwell, and R. Gregorowski. 2006. Two cultures and tragedy of the commons. *African Journal of Ecology* 44:1-5.

Lumley, T. 2006. survey: analysis of complex survey samples. R. package version 3.6-1

Mace, R. 1993. Transitions between cultivation and pastoralism in Sub-Saharan Africa. *Current Anthropology* 34:363-382.

Maitima, J, Reid RS, Gachimbi LN, Majule A, Lyaruu H, Pomery D, Mugatha S, Mathai S, Mugisha S. 2004. *Regional synthesis paper: The linkages between land use change, land degradation and biodiversity across East Africa*. Nairobi: International Livestock Research Institute; June 2004. Lucid Working Paper Series No. 42.

McCabe, J. T. 1990. Turkana pastoralism: a case against the tragedy of the commons. *Human Ecology* 18:81-103.

McCabe, J. T., S. Perkin, and C. Schofield. 1992. Can Conservation and Development Be Coupled among Pastoral People-an Examination of the Maasai of the Ngorongoro Conservation Area, Tanzania. *Human Organization* 51:353-366.

McCabe, J. T. 1994. *Wildebeest / Maasai interactions in the Ngorongoro Conservation Area of Tanzania.* USAID project report.

McCabe, J. T. 2003. Disequilibrial ecosystems and livelihood diversification among the Maasai of Northern Tanzania: implications for conservation policy in Eastern Africa. *Nomadic Peoples* 7:74-92.

McCulloch, W. S. 1945. A heterarchy of values determined by the topology of nervous nets. *Bulletin of Mathematical Biology* 7:89-93.

Milchunas, D., O. Sala, and W. Lauenroth. 1988. A generalized model of the effects of grazing by large herbivores on grassland community structure. *The American Naturalist* 132:87-106.

Mol, F. 1996. *Maasai: language and culture dictionary.* Maasai Centre Lemek, Kenya.

Muir, A. *A situational analysis of pastoralism in Simanjiro District, Tanzania.* VETAID; 1994.

Mwalyosi, R. B. B. 1991. Population-Growth, Carrying-Capacity and Sustainable Development in South-West Masailand. *Journal of environmental management* 33:175-187.

Mwalyosi, R. B. B. 1992a. Influence of Livestock Grazing on Range Condition in South-West Masailand, Northern Tanzania. *Journal of Applied Ecology* 29:581-588.

Mwalyosi, R. B. B. 1992b. Land-use Changes and Resource Degradation in South-West Masailand, Tanzania. *Environmental Conservation* 19:145-152.

Ndagala, D. K. 1982. 'Operation Imparnati': the sedentarization of the pastoral Maasai in Tanzania. *Nomadic Peoples* 10:28-39.

Ndagala, D. K. 1990. Pastoralists and the State in Tanzania. *Nomadic Peoples* 25-27:51-64.

Ndagala, D. K. 1996. The changing landscape of agro-pastoralism in Tanzania. In D. Schmied (editor), *Changing Rural Structures in Tanzania,* pp 129-140. Munster, Hamburg.

Ndagala, D. K. 1997. Land tenure and Maasai identity crisis. In F. Ibrahim, D. Ndagala, and H. Ruppert (editors), *Coping with Resource Scarcity,* pp 5-27. Verlag: Natuwissenschaftliche Gesellschaft, Bayreuth.

Nelson, F. 2005. *TNRF Workshop Report No. 8: Social and Ecological Dynamics and Complexity in the Simanjiro Plains: A Roundtable Discussion.* Tanzania Natural Resource Foundation, Wildlife Conservation Society, and Sand County Foundation, Arusha.

Netting, R. M. 1993. *Smallholders, householders :farm families and the ecology of intensive, sustainable agriculture*. Stanford University Press, Stanford, Calif.

Neumann, R. P. 2005. Making political ecology. Hodder Arnold, London.

Niamir-Fuller, M., M. D. Turner. 1999. A review of recent literature on pastoralism and transhumance in Africa. In M. Niamir-Fuller (editor). *Managing Mobility in African Rangelands: the legitimization of transhumance,* pp18-46. Intermediate Technology Publications Ltd., London.

Oakerson, R. J. 1992. Analyzing the commons: A framework. In D. Bromely (editor), *Making the commons work: theory, practice and policy*, pp 41-59. ICS Press, San Francisco.

Olson, JM, Misana S, Campbell DJ, Mbonile M, Mugisha S. 2004. *A research framework to identify the root causes of land use change leading to land degradation and dhanging biodiversity.* Nairobi: LUCID Project, International Livestock Research Institute; 2004.

O'Malley, M. E. 2000. *Cattle and cultivation: changing land use and labor patterns in pastoral Maasai livelihoods, Loliondo Division, Ngorongoro District, Tanzania.* PhD Dissertation, University of Colorado, Boulder.

Ostrom, E. 1990. *Governing the commons: The evolution of institutions for collective action.* Cambridge University Press, Cambridge.

Ostrom, E. 1999. Coping with tragedies of the commons. *Annual Review of Political Science* 2:493-535.

Ostrom, E., J. Burger, C. B. Field, R. B. Norgaard, and D. Policansky. 1999. Revisiting the commons: local lessons, global challenges. *Science* 284:278-282.

Owen-Smith, N. 2004. Functional heterogeneity in resources within landscapes and herbivore population dynamics. *Landscape Ecology* 19:761-771.

Pannell, D. J. 1999. Social and economic challenges in the development of complex farming systems. *Agroforestry Systems* 45:393-409.

Peet, R. and M. Watts. 1996. *Liberation ecologies: environment, development, social movements.* Routledge, London; New York.

Perkin S. 1995. Multiple land-use in the Serengeti region: the Ngorongoro Conservation Area. In A.R.E. Sinclair and Peter Arcese (editors), *Serengeti II: Dynamics, Management and Conservation of an Ecosystem*, pp 571-587. Chicago University Press, Chicago.

Perlez, J. 1989. The Proud Masai's Fate: Finally, to be Fenced In? *The New York Times* A:4.

Peterson, D. D. 1978. *Seasonal distributions and interactions of cattle and wild ungulates in Maasailand, Tanzania.* MS Thesis, Virginia Polytechnic Institute, Blacksburg, VA.

Potkanski, T. 1999. Mutual assistance among the Ngorongoro Maasai. In D. Anderson and V. Broch-Due (editors), *The poor are not us: poverty and pastoralism in Eastern Africa,* pp 199-218. Ohio University Press, Athens.

Pratt, D. J., P. J. Greenway, and M. D. Gwynne. 1966. A Classification of East African Rangeland, with an Appendix on Terminology. *The Journal of Applied Ecology* 3:369-382.

R Development Core Team. 2006. *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Austria.

Reid, R. S., S. Serneels, M. Nyabenge, and J. W. Hargrove. 2005. The changing face of pastoral systems in grass dominated ecosystem of Eastern Africa. In J. M. Suttie, S. G. Reynolds, and C. Batello (editors), *Grasslands of the World.* Food and Agriculture Organization of the United National, Rome.

Robbins, P. 1998. Authority and Environment: Institutional Landscapes in Rajasthan, India. *Annals of the Association of American Geographers* 88:410-435.

Robbins, P. 2000. The Practical Politics of Knowing: State Environmental Knowledge and Local Political Economy. *Economic Geography* 76:126-144.

Robbins, P. 2004. *Political Ecology: A Critical Introduction.* Blackwell Publishers,

Rogers, K. H. 2003. Adopting a heterogeneity paradigm: implications for management of protected savannas. In Du Toit, Johann T., K. H. Rogers, and H. C. Biggs (editors), *The Kruger Experience: ecology and management of savanna heterogeneity,* pp 41-58. Island Press, Washington D. C.

Saberwal, V. K. 1996. Pastoral Politics: Gaddi Grazing, Degradation, and Biodiversity Conservation in Himachal Pradesh, India. *Conservation Biology* 10:741-749.

Sanchez, P. A. 2002. Soil Fertility and Hunger in Africa. *Science* 295:2019-2020

Sankaran, M., N. P. Hanan, R. J. Scholes, J. Ratnam, D. J. Augustine, B. S. Cade, J. Gignoux, S. I. Higgins, X. Le Roux, and F. Ludwig. 2005. Determinants of woody cover in African savannas. *Nature* 438:846-849.

Schlüter, T. 1997. *Geology of East Africa.* Gebr. Borntraeger, Berlin.

Scoones, I. 1995. New directions in pastoral development in Africa. In I. Scoones (editor), *Living with Uncertainty: new directions in pastoral development in Africa,* pp 1-36. Intermediate Technology Publications, London.

Selasini, E., S. Waigwa. 2007. Maboskini in tears as slum comes to an end. *Arusha Times*: April 28:1.

Shivji, I. G. 1998. *Not yet democracy: reforming land tenure in Tanzania.* IIED / Hakiardhi / University of Dar es Salaam, Dar es Salaam.

Spear, T. 1993a. Being "Maasai," but not "People of Cattle." In T. Spear and R. Waller (editors) *Being Maasai,* pp 120-136. Ohio University Press, Athens.

Spear, T. 1993b. Introduction. In T. Spear and R. Waller (editors), *Being Maasai,* pp 1-19. Ohio University Press, Athens.

Spencer, P. 1993. Being Maasai, Being in Time. In T. Spear and R. Waller (editors), *Being Maasai*, pp 140-156. Ohio University Press, Athens.

Stark, D. 2001. Ambiguous Assets for Uncertain Environments: Heterarchy in Postsocialist Firms. In P. DiMaggio, W. Powell, D. Stark, and E. Westney, editors. *The 21st Century Firm: Changing Economic Organization in International Perspective,* pp 69-104. Princeton University Press, Princeton, NJ.

Steinhart, E. I. 2006. *Black poachers, white hunters: A social history of hunting in colonial Kenya.* Ohio University Press, Athens, OH.

Stocking, M. 1992. Land degradation and rehabilitation. Research in Africa 1980-1990: Retrospect and prospect. International Institute for Environment and Development. Paper No. 34.

Stone, G. D. 1996. *Settlement Ecology: The Social and Spatial Organization of Kofyar Agriculture.* University of Arizona Press.

Stone, G. D. 2001. Agricultural change theory. *International Encyclopedia of the Social and Behavioral Sciences.*

Sullivan, S. and K. Homewood. 2003. On non-equilibrium and nomadism: knowledge, diversity and global modernity in drylands. CSGM Working Paper No. 122/03:60.

Sullivan, S. and R. Rohde. 2002. On non-equilibrium in arid and semi-arid grazing systems. Journal of Biogeography 29:1595.

Swift, J. 1996. Desertification, narratives, winners and losers. In M. Leach and R. Mearns (editors) *The Lie of the Land: Challenging Received Wisdom on the African Environment*, pp 73-90. James Currey, London.

Tarangire Conservation Project (TCP). *Analysis of migratory movements of large mammals and their interaction with human activities in the Tarangire area in Tanzania as a contribution to a conservation and sustainable development strategy.* Milan: University of Milan; 1997 1997-1998.

Thompson, DM. 2002. *Livestock, cultivation and tourism: Livelihood choices and conservatino in Maaai Mara buffer zones*. London: University College London;

Thompson, M. and K. Homewood. 2002. Entrepreneurs, Elites, and Exclusion in Maasailand: Trends in Wildlife Conservation and Pastoralist Development. *Human Ecology* 30:107-137.

Tiffen, M., M. Mortimore, and F. Gichuki. 1994. *More people, less erosion :environmental recovery in Kenya*. J. Wiley, Chichester.

Tittonell, P., B. Vanlauwe, P. Leffelaar, K. Shepherd, and K. Giller. 2005. Exploring diversity in soil fertility management of smallholder farms in western Kenya II. Within-farm variability in resource allocation, nutrient flows and soil fertility status. *Agriculture, Ecosystems & Environment* **110**:166-184.

Tittonell, P., P. A. Leffelaar, B. Vanlauwe, M. T. van Wijk, and K. E. Giller. 2006. Exploring diversity of crop and soil management within smallholder African farms: A dynamic model for simulation of N balances and use efficiencies at field scale. *Agricultural Systems* **91**:71-101.

Tittonell, P., B. Vanlauwe, N. de Ridder, and K. E. Giller. 2007. Heterogeneity of crop productivity and resource use efficiency within smallholder Kenyan farms: Soil fertility gradients or management intensity gradients? *Agricultural Systems* **94**:376-390.

Turner, B. L. and S. B. Brush. 1987. *Comparative farming systems*. Guilford Press, New York.

Turner, B. L., R. Q. Hanham, and A. V. Portararo. 1977. Population Pressure and Agricultural Intensity. *Annals of the Association of American Geographers* **67**:384-396.

Turner, M. D. 1993. Overstocking the Range: A Critical Analysis of the Environmental Science of Sahelian Pastoralism. *Economic Geography* **69**:402-421.

Turner, M. D. 1998. Long-Term Effects of Daily Grazing Orbits on Nutrient Availability in Sahelian West Africa: I. Gradients in the Chemical Composition of Rangeland Soils and Vegetation. *Journal of Biogeography* **25**:669-682.

Turner M. D. 1999a. No space for participation: pastoralist narratives and the etiology of park- herder conflict in southeastern Niger. *Land Degradation & Development* **10**:345-363.

Turner, M. D. 1999b. Conflict, Environmental Change, and Social Institutions in Dryland Africa: Limitations of the Community Resource Management Approach. *Society & Natural Resources* **12**:643-657.

Upton, M. 1986. *Modelling economic outcomes of livestock production systems. Modelling of extensive livestock production systems.* International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia.

Van de Vivjer,

Voeten, MM. 1999. *Living with wildlife: coexistence of wildlife and livestock in an East African savanna system.* PhD Dissertation, Wageningen University, The Netherlands.

von Mitzalaff, U. 1996. Milking the cows and tilling the land? The bleak future of Maasai women in Handeni and Kiteto Districts, Tanzania. In D. Schmied (editor), *Changing Rural Structures in Tanzania*, pp 141-147. Munster, Hamburg.

Waller, R. 1988. *'Emutai'*: crisis and response in Maasailand, 1883-1902. In D. Johnson and D. M. Anderson (editors), *Ecology of Survival*, pp 73-113. Boulder, Westview.

Western, D., H. Gichohi. 1993. Segregation effects and the impoverishment of savanna parks: The case for ecosystem viability analysis. *African Journal of Ecology*. Nairobi **31**:269-281.

Wolmer, W. 1997. *Crop-livestock Integration: The Dynamics of Intensification in Contrasting Agroecological Zones: a Review*. Institute of Development Studies. IDS Working Paper **63**. Brighton.

Zimmerer, K. S. 2000. The Reworking of Conservation Geographies: Nonequilibrium Landscapes and Nature-Society Hybrids. *Annals of the Association of American Geographers* **90**:356-369.

Zimmerer, K. S., T. J. Bassett. 2003. *Political ecology: an integrative approach to geography and environment-development studies.* Guilford Press, New York.