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RESILIENCE AND PASTORALISM IN AFRICA SOUTH OF THE SAHARA, WITH A PARTICULAR FOCUS ON THE HORN OF AFRICA AND THE SAHEL, WEST AFRICA

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ABSTRACT

Recently there has been a great deal of interest in applying the concept of resilience to pastoral systems and to development programs in pastoral systems. This paper addresses pastoralism and its resilience in Africa south of the Sahara, with a primary focus on the Horn of Africa and some contrast to West African examples. It begins with an overview of the realities of contemporary pastoralism in this area that highlights social, economic, and political challenges and opportunities. It then focuses on the concept of resilience and its applications in the specific context of pastoral production systems. After discussing the general appeal of resilience for analyzing these systems, the paper illustrates specific elements of pastoralism that enhance or constrain household-level resilience. Empirical examples of adaptations by pastoralists in response to the challenges of resilience then are presented, followed by a discussion of recent development initiatives in pastoralist areas. The conclusion considers what the concept of resilience contributes to an understanding of pastoralist systems and the development initiatives that hold the most promise for enhancing resilience in the future.

Keywords: resilience, pastoralism, climate, food security, rural development

1. INTRODUCTION

This paper addresses pastoralism and its resilience in Africa south of the Sahara, with a particular focus on the Horn of Africa and some contrast to West African examples. It is based on the premise that enhancing resilience in pastoralist systems is a good outcome, although it questions how much the concept adds to what we already know about pastoralism and the theoretical frameworks that have been applied to its study, including those based on concepts such as poverty and vulnerability reduction, and sustainable livelihoods. The resilience concept has been applied in development thinking and practice for several years, but its recent popularity can be traced to two major concerns that have especially drawn the attention of policymakers and the international community. The first is climate change, with a particular concern for how to build resilient communities in the face of increasingly extreme weather events (DFID 2011; IIED 2012). The other is recurrent humanitarian crises, especially those traced to the most recent drought- and conflict-induced 2011 disaster in the Horn of Africa. Both of these phenomena have strong relevance for African pastoralism because many climate-change models show strong impacts in arid and semiarid rangelands (for example, Thornton et al. 2009) and recent humanitarian events have centered on pastoral areas (Gebru et al. 2013). That the multidonor initiative to "end hunger" led by the US Agency for International Development (USAID) invoked "building resilience" and "beyond relief" as mantras starting right after the 2011 disaster indicates that this event was important in propelling the concept of resilience to center stage in development planning and actions (USAID 2012).

Even earlier than 2011, a public and donor fatigue with recurrent food crises, especially in Africa south of the Sahara, had been growing. The 2011 disaster seemed to be the final straw that motivated major investments in and rethinking about how to move communities and whole regions from vulnerability to building resilience against the next disaster so as to avoid a humanitarian crisis. A perusal of USAID and UK Department for International Development (DFID) documents and supported research, for example, demonstrates how established resilience thinking has become in organizing the work and mission of both agencies in only the past few years (among many examples, see Bahadur, Ibrahim, and Tanner 2010; DFID 2011; USAID 2012; Vaitla et al. 2012; Béné et al 2012; Maxwell et al. 2013; Frankenberger and Nelson 2013; documents linked at USAID 2014). Other organizations involved in pastoral development have also elaborated on this theme (Glantz, Gommes, and Ramasamy 2009; Headey 2012; Tropical Consults 2012; Hesse et al. 2013; World Bank 2013).

Writing this paper has given us an opportunity to address pastoralism from the lens of resilience while balancing it with consideration of other concepts and frameworks that have been used to analyze this system. We write from the foundation of our work on pastoralism. Regardless of the discourse and concepts employed, the realities of African pastoralism and the challenges and opportunities that it faces are relatively consistent. As noted by Sobania (1979), the crux of pastoralism is that energy from the sun is stored in vegetation, and humans can obtain that energy through the intermediation of livestock. This adaptation to arid and semiarid areas has deep historical roots (for example, Robertshaw 1990; Homewood 2008). There are changes in the context of pastoral production that we will discuss in some detail below, but we wish to stress at the outset the fundamental resilience of pastoralism as a production system; it has allowed people to survive and even thrive in difficult production environments for centuries and even millennia. We anticipate that it will continue to do so but in a different form and accounting for a reduced percentage of the total population. Throughout the paper we offer our thoughts on how pastoralism can continue to build resilient livelihoods in arid and semiarid regions.

The paper is meant to provoke additional discussion, raise questions, and lay out a set of issues that require additional research and analysis, rather than to be definitive and prescriptive. No doubt thinking in terms of resilience rather than, for instance, vulnerability provides a more positive, forward-looking optic than is normal when discussing disheartening issues, such as widespread poverty, inequality, and hunger. It draws attention to those entities—individuals, households, communities—that have succeeded by being resilient,

who have been able to recover from a disaster or other shock. In this respect, it is important to note who and what succeeds—or achieves resilience by coping and recovering from a shock without a noticeable drop in welfare and assets or a detraction from transformative improvements—and to support the characteristics and practices that bolster these successes. However, it would be naïve and wrong to avoid considerations of history and context in terms of understanding what causes many individuals, households, and communities to be exposed to disasters and be unsuccessful (vulnerable) in achieving sustainable livelihoods. A danger with "resilience thinking," illustrated in this paper, is that it can result in understating the underlying reasons why so many poor communities are not resilient in the face of different hardships and shocks; why did they have to suffer the shock in the first place, from which we watch some of them bounce back while others do not? Further, by focusing mainly on the process of "bouncing back," we risk failing to ask the follow-up question: bouncing back to what living standard?

The paper is divided into six sections. Section 2 discusses the social, economic, and ecological characteristics of contemporary pastoralism in Africa south of the Sahara, with attention to the key drivers affecting change in pastoralist systems. It also directs attention to the key problems and development issues that pastoralism faces.

Section 3 is a discussion of what resilience is in the context of contemporary pastoralism. How does it apply to the challenges that pastoralists face and the opportunities to improve their welfare and capacity to cope with and recover from shocks? Section 4 gives examples of ways in which pastoralist households and communities have responded to new challenges.

Section 5 presents a set of local and regional initiatives that hold promise for strengthening resilience and improving the welfare of pastoralists against increasingly risky, shock-prone environments. The final section of the paper summarizes the main findings and discusses their development implications.

The materials in the paper are drawn from the literature as well as the authors' experiences and work on several different pastoralist research projects, including the Pastoral Risk Management (PARIMA) project (1998–2008), the Pastoralist Policy in Ethiopia project (2009–2010), the Climate-Induced Vulnerability and Livestock Marketing Chains in Southern Ethiopia and Northeastern Kenya (CHAINS) project (2012–present), the Mali Livestock and Pastoralist Initiative (2008–2013), and the Gestion des Systèmes Fluviaux pour l'Avenir (Management of River Systems for the Future) project in Senegal (2012–present).[1] Therefore, we will focus more on illustrating resilience in pastoralism based on what we have come to understand through our work than on providing a comprehensive overview of pastoral resilience in Africa, though we do hope to shed some light on the larger topic in what follows.

[1] The authors gratefully acknowledge the support of these projects and their funder, USAID. However, we claim full responsibility for the contents of the paper and none of the contents should be attributed to USAID.

2. THE CHARACTERISTICS AND REALITIES OF CONTEMPORARY PASTORALISM[2]

Four key challenges threaten the resilience of pastoral systems. These include land loss, conflict and violence, increased population and settlement, and climate variability and change.

LAND LOSS

The loss of pastoral rangelands is mainly caused by encroachment of neighboring agriculturalists and farming by herders themselves; development of irrigation, tourism, and conservation programs in key dry-season grazing and watering zones; and land investments ("land grabbing") by outside investors. Secure access to land and other resources, especially water, obviously is critical to the future sustainability of pastoralism. In fact, the loss of key resources, especially of dry-season grazing areas and watering points, will probably be the greatest challenge to mobile pastoralism in the next 25 years, a point that is supported by much current research (for example, Homewood 2008; Little et al. 2010; Behnke and Kerven 2011). These losses also will be spurred in part by population growth and by expansion of rainfed and irrigated agriculture (see discussion below). As Little and colleagues noted, "The loss of key dry season grazing areas, especially to irrigation schemes in riverine areas, crowds herders onto less productive rangelands, which undermines their economic welfare, puts them into competition and conflict with other groups, and aggravates environmental degradation. The net economic result is reduced quality of tradable products and animals for local sale and export, and higher costs for additional food aid for displaced pastoralists" (2010, 15).

Pastoralists have lost many valuable "patches" of highland grazing zones, river basins and wetlands, and forests to nonpastoral uses, including crop agriculture, forestry, and wildlife enterprises. Over the past 25 years this trend has been and continues to be well documented (Little and Horowitz 1987; Little 1987; Homewood 2008). The loss of land in pastoral areas usually removes the most productive drought-reserve areas, which are critical for the sustainability of a pastoral system, forcing herders to find grazing and water in already overused areas. Herder encroachment into forest reserves, national parks, and even cities like Nairobi during droughts reflects the disruptive effects of land alienation.

Some forms of land loss have been dramatic, such as the forced expulsion of herders from newly established protected areas or potential irrigation sites (Gebre 2001; Brockington 2002). National parks and reserves alone have removed hundreds of thousands of hectares of prime rangelands from pastoral use, turning them over to wildlife authorities for use by fee-paying tourists and, in some cases, licensed game hunters. While there have been some efforts to empower pastoralist communities to tap into the revenue stream from biodiversity conservation, this has typically proved difficult, due in no small part to weak community-level governance and elite capture of the benefits (Homewood 2008; Little 2014).

Other cases of land lost to pastoralism have been subtle and gradual, for example, the encroachment onto rangelands of cultivators—often ex-pastoralists—who settle permanently in former seasonal grazing reserves (Munyao 2005). This trend was noted in the 1970s and 1980s (Little 1987) but has accelerated in recent years, especially in places such as the Borana Plateau in southern Ethiopia (McPeak, Little, and Doss 2012), the slopes of Marsabit Mountain and the Hurri Hills in northern Kenya (Munyao 2005), and some Maasai areas of southern Kenya (Radeny et al. 2006). Vulnerability to local forms of agrarian encroachment is especially high in pastoral locations where land has been privatized and subdivided, and where rainfed agriculture is feasible (Homewood 2008). In West Africa, these processes threaten to cut off transhumance corridors that have long been used to allow international movements of animals into and out of zones that are

[2] Parts of this section are based on McPeak, Little, and Doss (2012) and Little and Dube (2011).

seasonally cultivated. The danger that these corridors could be rendered impossible to use by being choked off by cultivation has been the focus of some of our recent project work in Mali and Senegal.

The trend toward increased cultivation naturally changes the dynamics of land use. In particular, it creates new pressures for land privatization that were previously more subdued. One sees this manifest in land disputes that are most pronounced in areas going through transitions during the early stages of sedentarization (Yirbecho, Barrett, and Gebru 2004). Some communities are self-organizing effectively to maintain mobility in the face of seemingly unstoppable privatization of lands (Burnsilver and Mwangi 2007; Galaty 2013). But the trend toward privatization of lands poses new, considerable challenges for mobile pastoralism.

The loss of critical grazing lands affects pastoralist welfare, especially during droughts. A drought, defined as a 30–40 percent shortfall from average annual rainfall, can lead to large-scale livestock losses through starvation, especially of cattle. In both the PARIMA and CHAINS studies mentioned earlier, the lack of pastures and consequent starvation of animals was the first reason stated by pastoralists as the cause of livestock deaths during a multiyear period. This causal factor for losses was followed by animal disease, although the latter was also noted as frequently related to drought-induced pasture shortages because starving or weak animals are highly susceptible to disease and because the spatial concentration of animals becomes denser on the remaining available pastures, fostering disease transmission. As will be discussed later in the paper, the capacity to overcome feed shortages during critical periods of the dry season or a drought has multiple effects on pastoralist welfare and drought resilience.

CONFLICT AND VIOLENCE

A second major challenge for pastoralism is endemic conflict and violence that disrupts markets, leaves large expanses of rangelands unused while concentrating people and herds on remaining lands, and increases vulnerability during droughts. Take the pastoral areas of southern Ethiopia and northern Kenya, for example. For much of the past four decades, especially on the Ethiopian side of the border, the region has experienced a series of political upheavals. Significant political events have often resulted in conflict and insecurity, including the *shifta* uprising in northern Kenya in the 1960s, the fall of Ethiopia's governments in 1974 and 1991, armed conflicts in neighboring Somalia and Sudan that accelerated the flow of arms into the region, the implementation of an ethnic-based regional decentralization in Ethiopia that reinforced boundaries between groups (Bassi 1997), and the introduction of multiparty elections in Kenya with their associated violence in the 1990s and first decade of this century. In some parts of northern Kenya, political violence tragically has become associated with a scorch-and-burn policy whereby houses are torched by rival groups to clear entire communities out of contested areas. These same brutal tactics have been aimed at pastoralists in the recent violence in northern Mali, which also has constrained customary transhumance patterns and made large expanses of rangelands into "no go" zones (also see materials on Darfur, Sudan, in Gebru et al. 2013). At the same time several pastoral communities in East Africa increasingly have lost land to national parks and reserves, agricultural encroachment, forestry and irrigation projects, and expansion of towns and settlements, all of which further constrains their viability as well as facilitates conflict (Catley, Lind, and Scoones 2013).

Regardless of the causes, instances of violence and political instability have occurred in several pastoralist regions of Africa south of the Sahara, including northern Mali, Senegal, Nigeria, and Niger in the Sahel, and the recent major flare-ups in South Sudan and the Central African Republic. In addition, the larger political contestation is aggravated by the underlying livestock raiding and armed skirmishes between pastoral groups that have a long history in the region. However, these ongoing local conflicts took on a new and devastating dimension in the 1980s and 1990s with the increased use of modern weapons and violent attack strategies. The flow of small arms into pastoral areas made local-level skirmishes qualitatively more deadly and explosive than in the past. This trend has only worsened in the past decade. With armed conflicts in much of the Horn of Africa, especially in and near Somalia, South Sudan, and northern Uganda, small arms supplies

have grown significantly in recent years. Armed conflicts—and the fear of them—directly affect the resilience of pastoral livelihoods.

INCREASED POPULATION AND SETTLEMENT

There are an estimated 23.4 million pastoralists in the Horn of Africa (including Kenya), or about 14.8 percent of the region's population (Simpkins 2004, 3). The countries with the largest populations are Somalia, Ethiopia, Sudan, and Kenya, with Somalia and Eritrea having the largest percentage of pastoralists (an estimated 60 and 33 percent of total population, respectively) (Simpkins 2004, 3). Increases in human population and settlements in both the Horn and the Sahel constrain livestock mobility and encroach on available grazing lands. Three factors need to be disentangled here when considering population and settlements. One is population growth in pastoral areas, the second is the settlement of livestock keepers as they take on nonlivestock activities, and the third is immigration into livestock production areas by people from outside the area. These factors and their impacts on pastoral livelihoods are still not well understood. Certain studies show successful absorption of added population through intensification (that is, supplemental feed, crop residues, and intensive grazing strategies) (Turner, McPeak, and Ayantunde 2014; Moritz 2010), but others show increased overgrazing and reduced pastoralist welfare (Coppock et al. 2011). For example, in the Sahel region of West Africa, with more settlement and population there has been more intensive grazing (including night grazing) and labor use, and what Turner and Hiernaux call "shifts in labor" (2008, 74) with the growing integration of pastoral livestock and crop farming (Ayantunde et al. 2008; Turner and Hiernaux 2008).

The growth in settlements and towns also creates important market and employment opportunities that can support pastoralism as well as absorb individuals who are exiting pastoralism. These settlements are likely to continue to grow considerably faster than the population rate of rural pastoralists, which will help to spur an increasingly diversified economy but also make growing demands on range and water resources. For example, one key pastoral town in northern Kenya is Marsabit, whose population grew by more than 600 percent during 1969–1999 and has created exceptional demands on nearby water, forest, and grazing resources (Witsenburg and Roba 2004). As Little and colleagues noted, "These towns and the growth of rural-urban linkages will provide both opportunities and challenges to pastoral economies during the next 10 years" (2010, 2).

With regard to the opportunity facing livestock producers, large-scale urbanization, coupled with rising urban incomes, will increase the demand for milk and meat products (Delgado et al. 1999, Tambi and Maina 2003). In many African countries, much of this demand will need to be met from pastoral areas. For example, the growing consumption demand for animal products in Kenya means that about 67 percent of red meat consumed in the country comes from pastoralists (Juma et al. 2010, 135–138). The past few years have also seen rapid growth in meat exports and livestock prices in East Africa (Catley, Lind, and Scoones 2013). One important development challenge is ensuring that the benefits of this market opportunity are accessible to pastoralist producers.

CLIMATE VARIABILITY AND CHANGE

Extreme climatic events are likely to continue to affect pastoralists, livestock markets, and instances of animal disease in Africa south of the Sahara. As noted earlier, pastoralists may be especially vulnerable to future changes in climatic patterns. In fact, pastoralists themselves always have dealt with climatic uncertainties and variability. As analysts of pastoralist systems, we have long felt a tension between understanding how pastoralists respond to climatic variability (an ever-present challenge) and understanding how they respond to climate change (a potentially new challenge). In some sense, the question revolves around whether rainfall patterns and fodder production in livestock-producing areas are "stationary" or "nonstationary"—that is, whether the mean is changing over time or not. Although considerable uncertainty remains over the direction of climate change in the region's drylands, with some models predicting increased instances of floods rather than drought in some pastoral areas of Africa (Shongwe, van Oldenborgh, and van den Hurk 2011), extreme

events (either prolonged drought or flood) already have had major impacts on pastoral livelihoods and markets as witnessed most recently in 2011 (Nassef, Anderson, and Hesse 2009; Williams and Funk 2011). Unfortunately, by the time we have amassed evidence that could convincingly demonstrate that climate patterns have shifted (and that we have nonstationarity), our window of opportunity to effectively respond may have passed.

Whether climate change is happening in a given direction or not, one trend that will continue is that of impoverished ex-pastoralists who, for a range of reasons including inadequate access to grazing and herds, will not remain in pastoralism. “Shedding” of nonviable pastoral households has long been noted as a characteristic of pastoral societies (for example, Schlee 1989; Spear and Waller 1993; Little et al. 2001, Hodgson 2011). This trend is unlikely to diminish in the future and, if anything, will accelerate. Therefore, from a regional perspective, a successful pastoral system also should be one that has beneficial linkages with urban and nonpastoral sectors and the broader economy generally, so that those exiting pastoralism have livelihood options. This more positive scenario of rural-urban ties contrasts with the current situation wherein ex-pastoralists often cluster in unsustainable urban settlements and seek meager income from petty trade, unskilled labor, charcoal production and trade, and relief activities such as being engaged in food aid interventions.

3. WHAT IS RESILIENCE IN THE CONTEXT OF PASTORALISM?

Despite only recent applications of the concept in development, the use of resilience in analytical frameworks has been around for decades, especially in ecology (a notable early statement is that of Holling 1973; see also Adger 2006 and Resilience Alliance 2014). Bahadur, Ibrahim, and Tanner (2010) and Béné et al. (2012) have provided useful overviews of the concept as it has come to be used in development. Its elements also are embodied in other widely used concepts and applications encountered in development, such as sustainability and vulnerability. This section asks what is new about the resilience concept and about its application in the study of pastoralism and pastoralist development programs. Most of these different concepts and approaches encompass the idea of "bounce back," the capacity to prepare for, cope with, and recover from different types of shocks (climatic, economic, political, and other) without significant welfare loss or derailment of trajectories of welfare improvement. In this study we also compare and contrast different approaches to analyzing pastoralism and development, including "poverty traps," sustainable livelihoods, vulnerability, and political ecology, and ask how a resilience framework complements, strengthens, and possibly mutes understandings of the challenges and opportunities that African pastoralism confronts. In short, we want to know what resilience thinking adds to existing approaches and whether it merely mirrors what is already known but under a new label.

To begin, there are several reasons why resilience should appeal to researchers and practitioners in the context of pastoralism. These include the following:

- It is supportive of the notion of bounce back in the boom/bust drought cycles so prevalent in pastoralist areas (Behnke, Scoones, and Kerven 1993).
- It complements the "disequilibrium ecology" paradigm, which incorporates ideas of resilience, especially its focus on adaptations to unstable climate and ecological regimes (for example, Catley, Lind, and Scoones 2013; Leslie and McCabe 2013).
- It is consistent with notions of flexibility and mobility that are so critical in pastoralism (Moritz et al. 2010; Turner, McPeak, and Ayantunde 2014).

Any discussion of resilience and pastoralism should be rooted in livelihood analysis, which has been among the most prominent themes in pastoral studies conducted by academics, nongovernmental organizations (NGOs), and research institutes. Despite the widespread use of the resilience concept, much of this work has suffered from definitional problems and a lack of repeated observations of pastoral systems over longer periods of time. In pastoral settings, where boom and bust cycles play out over multiple years, and multiple such cycles can play out over a herder's pastoral career, observations over long time horizons may be essential to fully understand longer-term patterns. Resilience, sustainable livelihood analysis, and vulnerability analysis, by their very nature, can be evaluated only over time.

As noted earlier, resilience is a concept that has garnered considerable enthusiasm in the international development community during the past five years. The number of papers and reports, as well as development projects, that invoke resilience in their titles has grown exponentially, especially concerning dry regions of Africa. We noted above that the drought and the food crisis of 2011 in the Horn of Africa were instigating factors as governments and donors sought ways to rebuild and strengthen the region's local communities and production systems, and avoid debilitating cycles of drought / hunger / relief programs in the future. The focus on moving communities, including pastoralists, from a relief to a development mode is an approach that has been around at least for the past decade (Alinovi, Heimrich, and Russo 2008; LEGS Project 2009). According to the way USAID uses the concept, resilience is "the ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth" (USAID 2012, 5). In this delineation it is not enough just to recover to the same level of welfare as before a shock, but one must move beyond recovery

and improve welfare so that at each successive shock the system will be better prepared and recover to a higher level of welfare. DFID, in turn, defines disaster resilience as "… the ability of countries, communities and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses—such as earthquakes, drought, or violent conflict—without compromising their long-term prospects" (2011, 6). Finally, Oxfam invokes a definition that is considerably broader and based on rights: resilience is "the ability of women, men, and children to realise their rights and improve their well-being despite shocks, stresses, and uncertainty" (Hillier and Castillo 2013, 8). Resilience cannot be just about coping or bouncing back; although this is important, resilience building must be more than just speeding recovery from a shock. The Oxfam approach emphasizes an application that allows the poor to thrive despite the shocks and uncertainties of life.

Barrett and Constas (2013) adopted a definition of resilience that builds on Barrett's well-known work on poverty traps, much of it developed with collaborators evaluating evidence from East African pastoralist households (Lybbert et al. 2004; Barrett et al. 2006; Barrett and McPeak 2006; Carter and Barrett 2006). For them, resilience is the capacity to recover from shocks without falling into chronic poverty or a poverty trap. They importantly contributed the insight that there can be bad resilience (bouncing back to a poverty trap) and good resilience (bouncing back to a sustainable outcome) within the same economic environment.

The DFID definition above brings up the discussion of the scale at which we are to consider resilience. Much of the discussion in the literature has applied the individual or household scale. However, as indicated by the DFID definition, it is easy to see how the concept could apply at the neighborhood, community, landscape/ecosystem, national, or regional level. When there are connections between people, as there inevitably will be, the nature of how these connections function may play a role in determining the outcome for the individuals or households we are analyzing with a resilience lens and what it is that we see as enduring or adapting over time. For example, individual pastoralist households may pursue economic strategies, such as charcoal making or enclosing communal pastures, that may allow them to bounce back after a drought but have negative externalities at the community and landscape levels that make the overall pastoral system less resilient over time. This discrepancy points to a need to bring in the larger ecological, political, and social dynamics to understand resilience outcomes.

Further, these studies suggest that the concept of resilience can include dimensions of both the magnitude of the impact of a shock and the time it takes to recover from the shock. For example, in our pastoral context, household herds may both suffer different proportionate shocks and recover at different rates, depending in part on the species composition of the herd, where the herd composition is at least in part a reflection of decisions made by a herder. McPeak (2005, 184) reported that camel subherds in household herds in the Chalbi area of Kenya grew by 40 percent from 1993 to mid-1996 and declined by 22 percent in the second half of 1996. In contrast, goat and sheep subherds grew by 118 percent from 1993 to mid-1996 and declined by 70 percent in the second half of 1996. Adopting camels increases resilience by reducing vulnerability while also decreasing resilience by slowing recovery; adopting goats performs the inverse. Resilience in a pastoral setting provides a framework for understanding why we found in our PARIMA sample that 77 percent of herders had multiple species in their herds when we first surveyed them in March 2000 as they attempted to balance both dimensions of resilience.

So what contributes to resilience among pastoralists in addition to herd species composition? Here we discuss five key factors that need to be included in any discussion of pastoralist resilience.

MOBILITY

Several studies of pastoralism have confirmed the importance of herd mobility as a key risk-management strategy that herders employ under conditions of high risk and uncertainty (Niamir-Fuller 1999; McPeak 2004; Adriansen 2008; Turner, McPeak, and Ayantunde 2014). Because of the highly variable spatial and temporal distribution of rainfall and related vegetation conditions in areas where pastoralists live, herders are required

to be flexible and mobile, especially in the movement of their animals. Being able to access diverse grazing and water resources is critical to ensuring livestock survival, and mobility has been shown to allow herders to cope with and recover from shocks such as droughts, as seen in PARIMA data from Kenya (Table 3.1).

Table 3.1 Herder mobility and drought impacts

	Average per capita livestock (TLUs) 2000–2002	% decline March–December 2000	Average # of watering points used each quarter	% of households relying on mobile satellite camps
Kargi	7.0	0%	3.3	88%
North Horr	3.6	–24%	1.7	45%
Logologo	2.5	–46%	2.0	91%
Sugata Marmar	1.1	–33%	1.3	28%
Dirib Gombo	1.0	–79%	1.1	46%
N'gambo	0.6	–50%	1.5	1%

Source: Based on Little et al. (2008, 599).
Note: TLU = tropical livestock unit.

In the PARIMA study area of more than 125,000 km^2 in northern Kenya and southern Ethiopia, only 1 out of 11 research sites contains households that are fully nomadic.[3] Most pastoralists in the study area pursue a base residence / mobile camp model, wherein most family members typically reside in the same place throughout the year while mobile satellite camps of mainly young male herders move with the bulk of the animals (Little et al. 2008). In terms of consumption, it means that there can be an imbalance between where the people who need milk are (in the base residence) and where the livestock with milk perhaps primarily are (in the mobile camp). With the importance of milk for household income and, most importantly, for consumption, pastoralists are especially concerned with the productivity of their female animals. The mobility strategy improves animal productivity and hence milk production for local consumption as well as herd reproduction for growth. In work in the Senegal River Valley, we have found that the need for livestock mobility creates a significant imbalance between where pastoralists (especially women and children) who consume milk are and where the milk-producing livestock are situated. Herds vacate the communities following harvests and grazing of crop residue in November and return in July in a pattern of regional transhumance. In such a system, herd ownership may not translate into reliable and sustained nutritional benefits for all household members.

ACCESS TO CRITICAL PATCHES (AT THE LANDSCAPE LEVEL)

Rangelands are characterized by "patches" of high ecological value alongside large expanses of marginal range and shrub lands. Because of the uneven nature of dry landscapes, herders often rely on mobility, as we have shown, and move their animals across space to capture variations in forage and water availability. The ecological variation can occur due to differences in elevation or, at a given elevation, due to localized rainfall (or both effects combined). The value of these patches is especially revealed during long dry seasons and droughts, when herds can be decimated in a relatively short period of time (three to four months). How herders manage their access to these valuable sites during critical intervals determines the sustainability of the pastoral system as a whole. Consequently, it is not a coincidence that much of the conflict and insecurity in pastoral areas stems from competition over these resource patches. Government policy clearly is a driver of changes in land-use access because of its impact in the rangelands, especially with regard to the most productive ecological patches (especially river valleys). Policies normally favor nonpastoral uses of these important lands, with outside resources and public funds targeted toward irrigation and conservation

[3] Nomadism means that all household members, the herds, and the physical home move in search of good conditions for the livestock.

investments. The implication of these policies is that pastoral production systems lose access to their most productive patches, which reduces herd productivity and hence food availability and human nutrition. In prolonged dry seasons and droughts, the probability of animal deaths also can be higher when the use of valued patches, which often serve as fallback areas during extreme climate events, is removed from the system.

The Gabra system of northern Kenya illustrates how migratory patterns can come under strain in multiple dimensions. Historically, Gabra herders moved to the Hurri Hills during the rainy season to make use of surface pools of rainwater and freshly sprouted pasture. As the rains ended and the pools dried up, they would move down into the arid plains, where permanent water was available at springs and wells, and extensive pastures were available in areas where rain fell (Robinson 1985; Munyao 2005). As settlement and cultivation have grown on the Hurri Hills, from no permanent residents in 1974 to more than 250 households in 2003 (Munyao 2005, 43), seasonal use by nomadic herders has been constrained by the growth of fields and the increase in livestock owned by the permanent population on the Hurri Hills. In another direction, Gabra have historically used the area below the Ethiopia-Kenya border along the eastern shore of Lake Turkana as a prolonged dry-season grazing reserve (Robinson 1985; Munyao 2005). The accessible area was reduced by the creation of the 1,571 km^2 Sibiloi National Park in 1973 in this same area. Both highland and lowland grazing areas have been reduced as a result of these changes, constraining the mobility options discussed in the previous section.

MARKETS AND FOOD SECURITY

Concerns about markets and food security figure prominently into pastoralist resilience. Herders need to maintain market linkages to sell livestock and to buy essential grains, since they do not produce adequate cereals but consume them daily. As is well established in the literature, herds are not sufficiently large for most pastoralists to survive on direct consumption of livestock products (O'Leary 1985; Zaal 1998; McPeak and Little 2006). In terms of caloric value, herders do considerably better by selling animals to purchase cereals than by consuming animal products directly (Dietz et al. 2001). The terms of trade for herders wishing to sell animals to purchase grains become especially difficult during drought events, such as the recent 2011 emergency in the Horn of Africa. At the onset of an unusually low-rainfall period, a herder might assume the worst-case scenario, that climatic and livestock conditions will continue to deteriorate, and unload animals on the market. If many others follow the same logic, there is a shift outward of supply, leading to reduced prices even beyond the reduction generated by the animals' loss of condition due to poor grazing conditions. At the same time, there is a shift in demand outward in the grain market due to the lack of milk production for home consumption, and there is a possible supply shift inward if the drought is also impacting grain production zones, leading to higher grain prices. Since herders are very dependent on grain consumption and on livestock sales to finance it, they must continue to deal with the market even when conditions are very unfavorable. As McPeak, Little, and Doss pointed out, "There is large variability not only in the prices for livestock that pastoralists sell [especially during droughts], but also in the prices of the goods they buy" (2012, 55). During a drought, not only do prices for livestock decline but the variation around the mean also shows more volatility than in nondrought years (McPeak, Little, and Doss 2012, 56).

Despite impressive gains in livestock trade in the Horn of Africa during the past 10 years (Aklilu and Catley 2010; Farmer 2010; Farmer and Mbwika 2012), household income among pastoralists is still largely derived from milk production. If one looks at total household income (cash and subsistence values), livestock sales account for less than one-third of the value of income that is obtained from home consumption of milk produced by the household herd (McPeak, Little, and Doss 2012). Home-produced and -consumed milk accounts for 50 percent or more of the income for those herd owners with more than 2.0 tropical livestock

units (TLUs) per capita.[4] The importance of milk production in pastoral households is also confirmed by numerous other recent studies on the economics of pastoralism (Sadler et al. 2009; Little et al. 2010).

In terms of production and marketing decisions, pastoralist households generally either are managing risks associated with drought, recovering from drought, or preparing for the next disaster. Where the household is along this predrought, drought, and postdrought continuum affects its production and marketing decisions (Little 2013). For example, immediately after a drought, when herds are recovering, households often focus on goat production or buying goats, which breed relatively quickly. Later on, they often sell the goats to purchase cattle or trade them for camels. This species shift along the drought-to-drought recovery continuum has long been noted in livestock-producing societies (Dahl and Hjort 1976; Mace 1993).

An empirical example of this process is helpful for understanding how it works. Here we draw on observations of the 2011 drought in Ethiopia. After this disaster, herders used the market to purchase goats, which as mentioned above is an important drought recovery strategy (see also Little et al. 2001). During a 12-month period in 2012–2013, about 20 percent of herders in the CHAINS study purchased goats from either the market or other producers, and another 8 percent bought sheep, another species that reproduces relatively quickly and is a valued asset for rebuilding herds (Little 2013). Although it is too soon in this study to know what herders will do with the small stock that they purchased and the animals' offspring, other research suggests that they are likely to sell them back on the market after a few years and purchase cattle (Little 1992; McPeak, Little, and Doss 2012). It should be noted, however, that most herds and flocks are rebuilt after a drought through reproduction rather than purchases.

To better understand the price risks and market volatility that herders face, it is important to examine household production and marketing strategies across drought (crisis) and nondrought years. In most of the Horn of Africa, droughts occur on average every five to seven years, but since 1999 they have been taking place about every three or four years. In nondrought years, herders market animals in response to price, especially in postdrought periods when prices increase rapidly, but they also pursue food (milk) production and herd growth goals (McPeak 2005).

In some cases, holding animals off the market for reproduction rather than selling is sound as both a risk-management and an economic strategy. Our PARIMA work and other studies of pastoral systems suggests that herd accumulation is a viable strategy for coping with drought since an important predictor of postdrought herd holdings is the number of animals owned prior to the crisis (Fratkin and Roth 1990; McPeak 2005; Little et al. 2008; McPeak, Little, and Doss 2012). Again, returning to the example of the Gabra herds, McPeak (2005) found that herd size precrisis in 1996 was positively associated with herd size postcrisis in 1997; at mean herd size precrisis, one extra livestock unit in the herd corresponded to just more than half a livestock unit increase in 1997 postcrisis herd size. This is a costly form of risk management, but given the possibility of bifurcating asset dynamics in herd size (Lybbert et al. 2004), herd accumulation may be worth the cost to avoid having a postcrisis herd size that is no longer viable to support the household and rebuild the herd in the recovery phase.

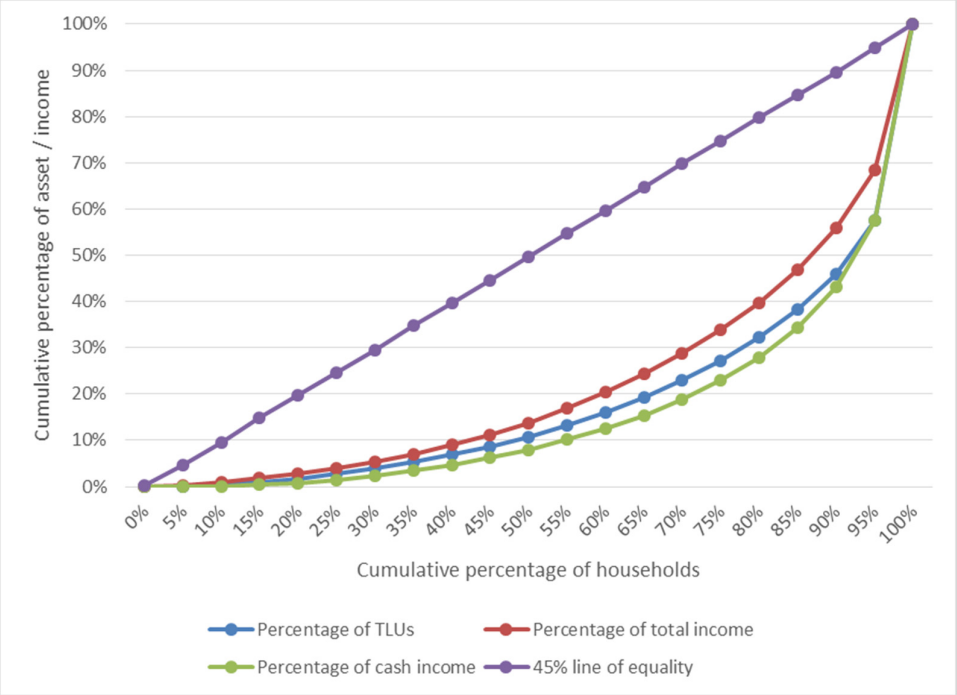
EQUITY ISSUES

A fourth issue to consider is the question, "Resilience for whom?" Pastoralist households are highly differentiated by wealth in a process that has seemingly accelerated during the past 25 years. Indeed, there is significant inequality in livestock ownership in most pastoral areas in the Horn of Africa and the Sahel (Mortimore 2010; Homewood 2008; Wane et al. 2010). For instance, the PARIMA research shows that the wealthiest 10 percent of herd owners control about 46 percent of aggregate TLUs, while the poorest 20 percent control less than 3 percent. A similar pattern of inequality exists in terms of control over cash income

[4] Defined here as 1 TLU = 1 head of cattle = 0.7 camels = 10 sheep or goats.

and total income, where the cash value of all home-produced and -consumed goods is added to cash income (Figure 3.1). This level of wealth differentiation affects the way different households (poor, middling, or better off) respond to market opportunities and their capacity to recover after droughts, especially given the variation in their cash needs and their access to different markets. Local markets that target local slaughter and consumption, for example, are the least selective in terms of the quality, age, and sex of animals. These outlets are more accessible to poor and middle-wealth households than other markets (Little 2013). The national domestic markets, which in the cases of Kenya and Ethiopia are centered in Nairobi and Addis Ababa, respectively, are more selective but also absorb older, poorer-quality animals for the low-income consumer market. Pastoralists often supply animals, via sales to traders, to these urban markets. There is a growing high-income, high-quality livestock market that is for upper-income outlets in the region or for export markets (Farmer 2010; Farmer and Mbwika 2012; Aklilu et al. 2013). Initial evidence indicates that most of the value-added income in this market is being accrued by wealthy traders and herders (Aklilu and Catley 2010, 2011; Little 2013).

Figure 3.1 Lorenz curves of income and livestock distribution



Source: McPeak, Little, and Doss (2012, 93).
Note: TLU = tropical livestock unit.

Let us now look at how these household wealth differences affect market sales in the household economy.[5] Livestock sales assume more importance for better-off households than for poorer households in total cash earned, although poorer households usually sell an equal or larger proportion of their herd annually (known as the *off-take rate*) than the wealthy do. That poorer herders have higher market off-take rates—measured here as the percentage of herd annually sold—can lead to their eventual exit from the pastoral sector, particularly if a minimum level of consumption that is required to ensure household subsistence is one possible contributor to the bifurcating asset dynamics noted previously. Because they often are forced to sell off a relatively large percentage of their animals in order to purchase foods and other necessities, their marketing patterns usually are unsustainable over the long term unless they find alternative means of earning

[5] This paragraph is based on Little (2013).

cash. With smaller herds, poor households have less milk and other animal products available for consumption than better-off households and thus depend on animal sales (and other cash-earning activities) and food purchases more than others.

The notion of thresholds is critical to understanding resilience theory in ecological sciences and has relevance to pastoralism and development. Similar to the notion of a "tipping point" in ecology—the point after which the ecosystem is transformed to a new state (Walker and Abel 2002; Walker and Salt 2006; Leslie and McCabe 2013)—there are tipping points or thresholds that have relevance to pastoralism. Indeed, two key tipping points have played a role in understanding pastoral systems and resilience. One is a subsistence constraint, variously defined, but roughly speaking, 2,000 kilocalories per day per adult. Below this level, basic metabolic functions are threatened and health status declines. Household decisions have to balance current against future consumption needs; if I sell a goat, buy grain, and eat the grain this month, I will not be able to sell that same goat to buy grain next month. A second tipping point is the herd size threshold. There again are various definitions, but the core idea is that there is a herd size per capita threshold above which a household is likely to remain a viable livestock-based production unit in the future and below which a household faces an elevated probability of becoming stockless in the future. Fratkin and Roth (1990), using a northern Kenya sample, estimated that herd sizes above 9 TLU per capita are capable of suffering drought losses and recovering. Between 4.5 and 9 TLU per capita, households may or may not be able to suffer drought losses and recover. Below 4.5 TLU per capita, households are not likely to be able to remain in the livestock production system in the future without other sources of income and livelihood. Lybbert and others (2004), as noted previously, provided similar findings for herders in the Borana plateau. Thus, households' management decisions are made to avoid the two undesirable outcomes of health consequences due to undernutrition and long-term destitution due to becoming stockless. Understanding the tension between these two tipping points is a key to understanding livestock management decisions made by pastoralist households.

GOVERNANCE AND POWER

The persistent dilemmas of land alienation, insecurity, and lack of access to services and infrastructure that impact pastoral resilience reflect deeper-seated problems of governance and political marginalization. Although the seeds of political powerlessness in pastoralist areas were planted during the colonial period, they have persisted and even grown in recent times. Pastoral parliamentary groups of politicians have now formed at national levels throughout the African continent. But it is difficult to see how they can meaningfully counter the strong forces that favor nonpastoral areas, whose far larger populations and economies endow them with formidable political influence. The strong inverse relationship between government-provided services and infrastructure investment and poverty levels in rural Kenya, for example, signals a mutually reinforcing relation wherein poorer areas, such as the arid and semiarid lands (ASAL), lose out in the political competition for scarce resources at the same time that the resulting infrastructure and services deficiencies contribute to these locations' poverty in the future (Okwi et al. 2007). Not only does political marginalization constrain investment but it also limits pastoralists' ability to compete for salaried employment in national labor markets. Minimal levels of education and skills training mean that most herders enter the labor market at the bottom rungs.

However, political marginalization is more than just an issue of neglect. It can also be a question of political powerlessness in the face of demands by outside actors. When confronted by outside interests and groups, pastoralists have been unable to effectively resist their actions. Wildlife, tourism, and commercial agricultural interests have been able to exploit large tracts of pastoral lands with the direct or indirect support of governments, NGOs, and international donors, and with little legal recourse by pastoral groups (Homewood, Kristjanson, and Trench 2009). Pastoralists must become more politically empowered if they are to improve their livelihoods and become more resilient. This process requires shedding fundamentally disempowering stereotypes (stigmas) that have impeded their voice for years. Herders have been cast as environmentally destructive agents of desertification; tradition-bound individuals that irrationally refuse to sell animals at any price; and uneducated, warring peoples largely uninterested in modern society and best left alone. These

stereotypes delegitimize pastoralists' political input because if they are like the stereotype, there is little point in encouraging their participation in shaping their own destiny. This attitude in turn fosters long-standing impulses to transform pastoralism through outside intervention "for their own good," a paternalistic treatment of "noble savages." Such ideas are as offensive as they are inaccurate (Little et al. 2008).

Pastoral areas have also experienced many political changes during the past 20 years that have further marginalized their populations and the resilience of their communities. These include increased political and administrative decentralization and multiparty politics (democracy), which on the surface seem beneficial but have provided most pastoral communities with little national and regional power. The persistence of the many antipastoralist narratives discussed above reflects pastoral communities' lack of political power. As recent studies have demonstrated, political decentralization unfortunately also has been associated with minimal devolution of power from the center to pastoralist leaders and communities (in the cases of Sudan and Ethiopia: Hagmann 2005; Babiker 2013) or with elite capture by local leaders resulting in inequitable distribution of resources, especially for poor pastoralists (in the cases of Kenya and Tanzania: Igoe and Brockington 2007; Homewood 2008). National political processes will continue to matter for pastoralists in the region, and efforts by pastoral communities and activists to influence these processes should continue. However, at the same time, training and research on effective models for empowering pastoralists at different levels of the state, including the community and district levels, also should be pursued.

4. EXAMPLES OF PASTORALIST RESPONSES

This section presents examples of new herd management strategies, diversification, and pastoralist intensification, which highlight ways in which pastoralist households and communities have responded to new challenges and opportunities to enhance resilience. What are the more resilient households doing to make themselves more resilient, and what do their responses imply for future policy and programs in pastoral areas?

HERD COMPOSITION

As noted above, herd composition can be a strategic choice to manage household resilience. In a similar fashion, adapting herd composition is one way in which pastoralists respond to changing environmental conditions. As perennial grasses become scarcer due to changing environmental conditions, bans on bush burning, or stocking pressure, herders adapt by increasing the share of the herd composed of hardier, browse-dependent goats and camels. They also may adopt breeds of animals that are more marketable or have higher potential for value-added finishing, though sometimes these strategies come at the price of drought susceptibility (Radeny et al. 2006).

The increased frequency of drought and large cattle die-offs in southern Ethiopia are affecting the species composition of herds in the region. Layne Coppock's work suggests that since the mid-1980s, cattle in Borana, southern Ethiopia, decreased from 92 percent of total TLUs to about 78 percent of TLUs, with goats and camels making the largest gains as a percentage of total TLUs (Coppock 2013). There are at least three possible explanations for this trend.[6] One is that bush encroachment due to the ban on burning pasture has made the production environment more conducive to browsing goats and camels than grazing cattle. The second has to do with the differences between species in terms of drought resistance and reproductive speed. Camels are especially drought resistant and produce considerable quantities of milk/food in dry seasons when other livestock produce minimal milk. Goats reproduce more rapidly than cattle. The third explanation lies with market signals. During prolonged dry seasons and droughts, prices for camels decline relatively little compared with those of other animal species. For example, Barrett and colleagues (2003) showed that prices for camels in northern Kenya decline an average of 4–12 percent during dry seasons, while cattle prices drop by as much as 60+ percent. Sheep also experience steep drops of 40 percent or more in price from wet to dry seasons, but prices for goats are less volatile, with about a 20 percent price decline in dry seasons (Barrett et al. 2003). Moreover, due to both increased local demand and growing demand for camels and goats on international markets (that is, the Middle East and North Africa), camel and goat prices have grown considerably faster than prices for other animal species, according to analysis of the livestock market information system data for Kenya and Ethiopia.[7] For camels, which increasingly are being exported from Ethiopia to Sudan and then eventually to Egypt, average prices have doubled in just the past two years (Aklilu and Catley 2011). Further research could help identify the relative contribution of each of these explanations to the observed herd composition change.

INTENSIFICATION OF PRODUCTION

Another adaptation strategy is changing production techniques. For instance, as noted above, some herders are enclosing large areas for their own private use and for protection against competing land claims, while others are purchasing fodder and supplemental feeds to compensate for decreased pastures (Aklilu and Catley 2010; Gebru et al. 2013). Relatedly, the growth in livestock trade from the Horn of Africa, especially the high-value export trade focused on male cattle aged four to seven years, has led large herders and traders to enclose communal lands, either illegally or legally, to fatten and graze their trade animals. This fragmentation

[6] This section is based on Little (2013).

[7] www.lmiske.net and www.lmiset.net, respectively.

of rangelands in the Horn is likely to grow and continue to transform landscapes, ecologies, and herd management practices (Homewood, Kristjanson, and Trench 2009). Moreover, better-off herders have innovated by hiring water trucks as well as trucking fodder and animals during periods of shortage. While these are important innovations, it is also worth noting that these strategies both require wealth and will further aggravate local wealth differences (Aklilu and Catley 2010; Catley, Lind, and Scoones 2013).

LIVELIHOOD DIVERSIFICATION

Household-level diversification out of the livestock-based economy is occurring in pastoral areas and has been an important response to the challenges in these areas that were discussed earlier (Little 2009). Our findings from the PARIMA project indicate that the most successful households combine access to the livestock economy and access to the cash economy. Overall, the PARIMA data show that households rely on nonlivestock-related activities and sources to obtain more than a third of their total income (McPeak, Little, and Doss 2012). The “moving from” and “combining” groups are particularly notable examples of this kind of livelihood adaptation. In fact, the “moving from” group obtains as much income from nonlivestock-based sources as it does from livestock-based sources. However, it is also important to note that many forms of diversification are pursued out of desperation, based on survival. While wealthier herders increasingly pursue nonpastoral investments and activities with the goal of supporting, not replacing or exiting from, pastoralism, a more negative kind of diversification from the livestock-based economy is found among those who have lost all their livestock and are trying to find any way they can to survive.

5. REGIONAL AND LOCAL DEVELOPMENT INITIATIVES

This section examines local and regional development initiatives to enhance pastoralist production systems, marketing, and food security. It particularly looks at innovations by NGOs in their efforts to assist pastoralist communities to better withstand and recover from shocks, such as droughts, and to build more resilient livelihoods and economies. It examines both international and local NGOs, as well as donor-funded development initiatives, with a focus on efforts that strengthen pastoralist production and marketing systems, as well as those that assist households transitioning out of pastoralism.

DROUGHT CYCLE MANAGEMENT

Emergency provisions of veterinary inputs and feeds during shocks to save livelihoods and reduce vulnerability to chronic poverty and hunger also have been studied under this general theme (LEGS Project 2009). Some of this livelihoods-based work has been conducted in the context of humanitarian studies, with groups like Tufts University, the UK Overseas Development Institute (ODI), Save the Children Fund–UK, Oxfam, Vétérinaires Sans Frontières (VSF), and the Livestock Emergency Guidelines (LEGS) playing prominent roles in the past decade (for case studies of NGO efforts to save pastoralist livelihoods and assets during emergencies in Sudan, see Gebru et al. 2013). The themes have been especially prominent recently as instances of humanitarian crises, especially drought- and conflict-induced, have increased in dryland areas. As Little and others noted, work in the general area of pastoralist vulnerability and external shocks "leads us to the growing field of drought cycle management, where the challenge is to identify innovative means to help pastoralists prepare for and cope with shocks in ways that do not inhibit the effectiveness of existing strategies to deal with such events" (2010, 12). The works of Tufts and others have shown that the costs of restocking herds after a drought greatly exceed the costs of emergency provisions in feed and commercial destocking during a drought and prior to massive herd die-offs (PLI 2007).

REGIONAL AND CROSS-BORDER COORDINATION

An analysis of pastoral development efforts indicates the growing importance of approaching such development in a regional context. This context allows for better understanding of rural-urban linkages, remittances, town-based pastoralists and ex-pastoralists, different value chains that can involve multiple stages, and spatial migration patterns that can be international in scope. As an example, Frankenberger and Nelson wrote of the African Risk Capacity (ARC) initiative:

> The ARC represents a paradigm shift from managing crises to managing risks … the ARC provides a framework for drought risk financing (e.g., reserves, contingency lines of credit, weather-indexed insurance) that emphasizes monitoring and early warning, vulnerability assessment and mapping, emergency response, and financial planning and risk management. A recent cost-benefit analysis of the ARC reported that early intervention can result in gains of over US$1,200 per household assisted. While most African countries have early warning systems that alert decision-makers of deficits in rainfall or grain availability, these systems are not linked to financial mechanisms that allow governments and others to respond quickly. Rather, humanitarian emergency responses often lag behind the onset of emergencies by six or more months, well after those affected need it most. (2013, 26)

Frankenberger and Nelson (2013) also cited another promising regional initiative, the Cross Border Drought Preparedness Project implemented by VSF, which focuses on reciprocal grazing and water agreements between neighboring communities across international borders. It recognizes that resilience among pastoralist communities is often contingent upon their being able to move their herds across international boundaries at certain times of the year and especially during droughts. These customary transborder pastoralist movements are common in both West Africa and the Horn of Africa (Sulieman and Ahmed 2013).

The VSF initiative is similar in its basic premise to an approach advocated by ODI along the northern Kenyan–southern Ethiopian borderlands. Here ODI researchers have observed local initiatives of pastoralist communities to establish cross-border committees of herders to reduce grazing conflicts and facilitate herd mobility when conditions require it. Pavanello and Levine noted:

> Cross-border committees involve representatives of both state and customary institutions, and they operate by blending formal (state) and informal (indigenous) rules and mechanisms in a hybrid structure. Although they have no official status, some are taking on roles as authorities in natural resource management, and are becoming the structures through which some communities are negotiating or claiming rights to access grazing land and water sources. Since state institutions cannot possibly govern rangeland management, and since customary authorities are being undermined by state officials, such hybrid institutional arrangements could represent a compromise, offering what some pastoralists called a "modern" approach to cross-border rangeland management. (2011, 1)

Based on the importance of mobility and flexible tenure arrangements, these kinds of efforts hold considerable promise to strengthen local resilience, especially during droughts. In a legal sense, West African states, including Chad, Mali, and Niger, have gone much further in codifying the legality of transborder livestock routes and ensuring that pastoralists have access to long-distance trekking and watering corridors. As Hesse and colleagues confirmed, "The strategic importance of livestock mobility at regional level is now recognised by the ECOWAS [Economic Community of West African States] Transhumance regulations, which facilitate livestock mobility between the 15 member states" (2013, 6). The Lake Chad Basin Authority, representing several West African states, also ensures that seasonal movements of herds and people in the basin are legally permitted (Moritz et al. 2013). To our knowledge, no such formal protocols exist between any East or Horn of Africa states, but they should be an important element of any policy discussions of resilience and pastoralism (according to Fitzpatrick and Young [2013], a formal protocol existed between Sudan and South Sudan that allowed cross-border pastoral movements, but it broke down in 2012 and, given the current conflict in the region, is unlikely to be revived in the near future).

INDEX-BASED LIVESTOCK INSURANCE

Livestock transfers between households have been investigated by various authors as a means of dealing with the risk of asset loss (Perlov 1986; McPeak 2006; Moritz 2013). Over the past five years, the USAID BASIS project and other donors, in collaboration with the International Livestock Research Institute and a larger research network, have been developing and extending index-based livestock insurance (IBLI) as a market-based approach to risk management in northern Kenya. A variant of this product was also launched recently in southern Ethiopia.

The basic concept is that if there are historical records of covariate livestock mortality, such as exist in northern Kenya because of the World Bank–funded Arid Lands Resource Management Project (ALRMP), these records can be regressed on historical remote-sensed satellite imagery of rangeland condition. In the northern Kenya case, a remote-sensed normalized difference vegetation index (NDVI) was available for each 10-day period for 8 by 8 km blocks from 1981 to the present from the Advanced Very High Resolution Radiometer product produced by the US National Oceanic and Atmospheric Administration (NOAA). The historical community-level mortality data from ALRMP monitoring efforts was regressed on NDVI data to develop an index (further details are contained in Chantarat et al. 2013). The index uses this historical record to provide real-time predictions of covariate mortality. Given the prevailing vegetation conditions that are captured by remote-sensed NDVI, the index generates an estimate of community-level covariate mortality rates.

Contracts are written between insurance companies and livestock keepers at the start of a given season (and backed by reinsurance companies) to provide compensation payments to herders based on the predicted mortality levels at the end of that season as predicted by the NDVI data that prevailed in that season. Notably, compensation is triggered only once a specified threshold mortality (15 percent, for example)

has been surpassed. Insurance compensates only for losses in excess of the threshold. Further, contracts are sold on a TLU basis, so compensation is proportionate to the number of contracts purchased, not the actual herd size or even the magnitude of losses realized by a herder buying insurance (further implementation details are contained in Mude et al. 2011).

As can be imagined, extension is a critical component of ensuring that herders understand how this product works and what it can and can't do for them (McPeak, Chantarat, and Mude 2010). Extension messages stress that compensation is provided only after a threshold mortality is reached, only in the season for which insurance was purchased, and based on the number of contracts bought as compared with actual losses suffered. Monitoring surveys conducted by this project indicate a remaining pronounced lack of understanding that the contracts are tied to a specific time frame; that payments reflect predicted covariate loss, not actual loss; that a level of loss up to the trigger is uncompensated; and that one has to buy the insurance to be eligible for compensation. Currently analysis is underway to investigate the effectiveness of alternative extension methods for ensuring understanding of the insurance product.

Evaluation of the project's impact is in the initial phases. Two studies undertaken using the program's monitoring and evaluation data reached some tentative conclusions of how insurance was used in the 2011 drought. Carter and Janzen (2012) and Janzen and Carter (2012) found that households that purchased insurance and received insurance payouts were less likely to reduce consumption and more likely to be net livestock purchasers than households that did not purchase insurance. These conclusions indicate that further analysis and research may reveal behavioral changes brought about by the presence of insurance.

It will take time and effort to move livestock production in East African drylands toward a market-based insurance system. It should be noted that the development, extension, and monitoring of the insurance product have all been undertaken with significant external resources in pilot projects. Donor funds further subsidize the product by setting the average purchase price at 60 percent of the price received by the insurance company. Whether there will ultimately be a viable private sector–provided IBLI product with no need for donor or government support is a question that remains to be answered. It may ultimately prove that the future feasibility of IBLI or similar products as a viable resilience tool requires longer-term government or donor support; at this point in the pilot program the ultimate outcome is not yet known.

SAFETY NETS

Another prominent development intervention in pastoral areas has been the introduction of safety net programs. Ethiopia has the Productive Safety Net Programme (PSNP) and Kenya has the Hunger Safety Net Programme (HSNP). Both programs regularly deliver either cash or food (or a combination) to households selected using various targeting mechanisms (community-based identification of those most in need, dependency ratio) or individuals (based on age). In some cases, these interventions are coupled with additional training, while in others they are tied to the provision of local public goods such as tree plantations, road repair, or soil erosion efforts.

Although long-term monitoring will be needed to assess the effectiveness of these programs, initial evidence leads us to the following preliminary conclusions. First, the PSNP in Ethiopia had as a goal the eventual graduation of households from poverty after a period of time. However, the mechanisms that would turn regular cash transfers into an escape from poverty were never fully articulated. As evaluation results have been analyzed, it appears the PSNP leads to graduation only when coupled with complementary training and innovation. Similar findings have come from draft evaluations of the HSNP program; some evidence suggests that households receiving transfers do not suffer the same magnitude of consumption shock as nonrecipients during a drought (Jensen 2012; Merttens et al. 2013). However, no statistically identifiable long-term changes in household wealth have yet emerged. In this sense, the programs do seem to decrease vulnerability and increase resilience, but they need to be coupled with a complementary innovation to lead to long-term growth and a pathway out of poverty.

EARLY WARNING SYSTEMS, MARKET INFORMATION SYSTEMS, CLIMATE INFORMATION

We write here of the systems with which we are most familiar, rather than attempting to provide an overview of information systems in pastoral Africa.

Donors have been actively supporting early warning systems in pastoral areas of Africa for several years. The technical sophistication and accuracy of these systems is impressive. On-the-ground work in Kenya by the Arid Lands Program provided an abundance of data with which to assess how well and how far out we can predict a looming food security crisis (as well as the data used to develop the IBLI product discussed above). Mude and others (2009) used this dataset's measures on herd composition and management; climate and forage conditions as captured by rainfall, NDVI measures, and seasonality; and food aid flows to forecast child nutritional status dynamics (as captured by mid-upper-arm circumference, or MUAC, measures of children). They found that "the joint dynamics of herd composition and herd management, climate and forage availability and food aid flows are able to forecast child nutritional status dynamics with impressive precision. Forecasting the proportion of children that fall below a critical nutritional threshold (proxied by a threshold MUAC value, a relevant parameter for assessments of the intensity and severity of a humanitarian crisis), yielded particularly accurate predictions. Moreover, offering policy-makers more response leeway by forecasting three months into the future only marginally reduced forecast performance relative to a one-month ahead forecast" (Mude et al. 2009, 338). However, to date the model has not been adopted and remains a tool that could be adopted.

In a related fashion, researchers at Texas A&M University have been supporting development of livestock market information systems in Kenya, Ethiopia, Tanzania, and Mali.[8] Trained enumerators are placed in livestock markets and record information on the types of animals sold, the volume of sales, and the price per category of animal sold (for example, adult male castrated fat zebu). These values are sent by text message to a server, where they are quality checked and posted online. Producers who have received training are able to send a text message query to the server to ask for specific market information that will be sent as a text message reply. The reliability and scope of these information systems are impressive. However, they remain at this state mostly helpful for understanding how markets work and have yet to achieve their potential for improving market efficiency and producer prices. They are perhaps thought of as a necessary condition; in Mali we worked to develop least-cost ration fattening technologies to accompany the market information system. The view was that fattening operations would complement market information systems. This remains an untested proposition, work having been suspended mid-project due to the recent political unrest in Mali.

Climate information systems have also been identified as a potential development tool in pastoral areas. The idea is that if we can provide better information to producers, they can make better decisions and avoid losses. In 2002, we surveyed herders in Kenya and Ethiopia to understand how they use climate information. Results indicated they understood probabilistic forecasts and updated predictions based on forecasts, but had very limited management options that were influenced by forecasts (Luseno et al. 2003; Lybbert et al. 2004). A similar set of questions was asked of Ethiopian herders in the CHAINS household survey in 2012–2013 with very similar results: more than 90 percent of pastoralists continued to rely on customary techniques of weather forecasting as their primary source for weather information.

A unifying theme is that these types of efforts at forecasting are best understood as enabling conditions for improving resilience and development outcomes. Each is based on high-quality information gathering, allowing us to make informed predictions. They have yet to realize their full potential by being integrated into household-level management decisions or policy decisions to enhance resilience. That remains a challenge before us.

[8] www.lmiske.net, www.lmiset.net, www.lmistz.net, and www.malibetail.net, respectively.

RESTOCKING

Heffernan, Misturelli, and Nielsen (2001) have provided some of the most in-depth analysis of restocking programs. They found that the objectives of restocking programs are at times misaligned with the intentions of poor residents of pastoral areas. For example, the majority of recipients, who often are among the poorest members of the community, do not see their future as a return to a rural, pastoralist livelihood. Instead, they see their future in commerce and through education because even with a restocking package of animals many are unlikely to return to full-time pastoralism. In some cases, they are more interested in selling the animal they are given as part of the restocking program in order to invest in a business or in education than in building a herd. There is also the question of gender targeting in restocking programs. Livestock, with notable cultural nuance, are generally owned by males. Restocking programs often focus on females. This practice leads to a possible mismatch, with viable migratory herds owned by males and small, peri-urban herds owned by females. Neither of these points suggests that restocking is not helpful but instead that it is limited in supporting resilient pastoral livelihoods, though it may support resilient peri-urban livelihoods.

One also can question the size of restocking programs, given the thresholds noted above (4.5 TLU or 9 TLU), which are the equivalent of around 45 to 90 small stock. This is far beyond the amount given by most restocking programs. As discussed earlier, Carter and Barrett's (2006) analysis demonstrated that it may be more effective to target those households with herds around critical thresholds such as 4.5 TLU to keep them from the path to the "bad" steady state of asset loss and move them toward the "good" steady state.

EDUCATION

Local demand for education is consistently high among pastoralists, a pattern that was not the case even 15 years ago, and it strongly affects access to employment and national political processes. It has been documented that during droughts educated pastoralists with urban-based employment are able to help their families purchase foods and thus avoid the worst effects of disasters (Little, Aboud, and Lenachuru 2009). Only minimal research has been conducted on the benefits and costs of education for pastoralists, in part because until recently formal education has not been widespread among herding communities. Recent trends, however, argue that education should figure prominently in discussions of contemporary pastoral risk management strategies because engagement in labor markets, which is facilitated by education, currently is a critical component of pastoral livelihoods. In some pastoral areas, livelihood and income diversification also has increased along with the growth in education levels.

Large losses of livestock usually, but not always, result in a humanitarian/food crisis for pastoralists. As McPeak and Little (2005) argued, herds can be severely damaged by drought but food security not overly jeopardized if there is nonpastoral income to purchase food. In fact, there is little doubt that education and nonpastoral employment, especially salaried work, have had important positive impacts on local food availability and expenditures. Income from employment is used to help cover food shortfalls resulting from drought and other disasters, such as floods. In a study in Baringo, Kenya, Little, Aboud, and Lenachuru (2009) showed that households having a member "with secondary school education" (including those with postsecondary schooling) were about 10 times more likely to have salaried employment, twice as likely to remit income, and 6 times as likely to find employment outside the area, and they expended almost 3 times as much on "sharing with relatives" as "without education" homesteads. The data also demonstrated that overall food availability was better among "with education" than "without education" homesteads because of the former's ability to purchase food on the market rather than rely on livestock production and sales.

Overall nonpastoral income has aided households to cope with food problems associated with drought, even when livestock losses are high. As noted earlier, homesteads whose members have more education are more likely than others to have nonpastoral income, especially from regular salaried employment. Investment in education is a key diversification strategy that increasingly allows herders to cope with the vagaries of drought and other economic shocks. Educated individuals also seem better able to time

animal sales according to market conditions than others, because they are not driven as much by cash requirements and the need to sell animals, often at throwaway prices, in order to procure food. They can wait out unfavorable markets, which cash-strapped and hungry pastoralists find hard to do. The effects of increased education on drought resilience among pastoralists is a topic that requires additional research.

RURAL-URBAN LINKAGES

On a regional level, the growth of ex- or nonpastoralist communities in the Horn is considerably faster than the increase in populations of pastoralists themselves. Spatial diversification contributes to resilience, and towns where many ex-pastoralists reside are an increasingly important part of the pastoral landscape. Some pastoral systems of the Horn of Africa are maintained through strengthened rural-urban links, including remittances from waged workers. The example from Baringo, Kenya, mentioned above shows this to be the case, while our earlier conceptual model shows that cash income can help households bounce back from drought. In their study of six pastoralist communities in northern Kenya and five in southern Ethiopia, McPeak, Little, and Doss (2012) found that non- or ex-pastoralists and "pastoralists exiting pastoralism" outnumbered active pastoralists—those who mainly focused on livestock rearing. What are the implications of these trends? First, if the number of non- or ex-pastoralists will soon exceed the number of active pastoralists in the rangelands, political decentralization and development investments may be even more skewed toward nonpastoralists and their priorities. Second, the capacity for pastoralism to absorb additional people (and labor) is limited relative to other production systems (for example, irrigated agriculture), which suggests that the trend of unviable pastoralists (that is, those with low levels of livestock) moving into local towns is likely to continue, or even accelerate in the future. USAID and others rightly are concerned with the relatively high numbers of families exiting pastoralism through drought, due to conflict, or by choice, and have initiated microenterprises, skills training, and other investments to create meaningful livelihoods for them. What needs to be remembered, however, is that in African rangelands nonpastoral employment and enterprises still revolve mainly around livestock production and marketing activities (Little et al. 2010). For example, livestock trade in southern Ethiopia generates the largest number of jobs in the Borana area, in activities such as transport, petty trading, market broker services, and fodder production and sales.

Comparative demographic research is needed to identify and compare fertility and population growth rates among pastoralist and settled populations in rangelands, building on earlier demographic work in the region (Fratkin and Roth 2005) and elsewhere in Africa (Randall and Hampshire 2005). With high population growth, the importance of rural-urban linkages in pastoral areas, a topic that remains poorly understood in the Horn, is likely to grow and significantly influence the future resilience of pastoralism. Vibrant local towns, with strong and beneficial linkages to surrounding pastoral hinterlands, are more likely to retain economic value and multipliers associated with pastoralism in local areas than are stagnant towns. Regrettably, most of the value-added from livestock trade and other activities (for example, tourism) currently is lost from the rangelands to outside regions and cities.

There is little question that pastoralists will continue to diversify their incomes and assets as buffers against risk (especially drought-related risk), as forms of investment, and as means to supplement or replace livestock-based incomes. As towns and new markets grow and technologies change, the nature of diversification in pastoral areas, as well as its linkages to pastoral production, will increase in complexity. The growth in small towns and importance of education discussed above suggest new opportunities for diversification, both unskilled and skilled labor, trade, and business investments. We also are likely to see labor migration from pastoral areas and remittance-based incomes continue to grow, and increasingly they will help households remain in pastoralism as families use remittances to purchase food, livestock, and livestock inputs. On the other hand, for the poor who have exited or are exiting pastoralism due to drought or other hardships, alternative livelihoods should be sought and external assistance may be required.

6. CONCLUSIONS AND DEVELOPMENT IMPLICATIONS

In spite of the challenges and changes that have been described in this paper, it is important when discussing pastoralist development to think about what a successful (resilient) pastoralist system looks like now and what it might look like in 10–15 years. Like the concept of sustainability, the resilience framework pushes researchers and policymakers to think in terms of the future and to highlight what works. From the perspective of livestock owners, a successful pastoral system is one that can successfully cope with and recover (bounce back) from the normal range of shocks (especially droughts) that are confronted in drylands. To sustain a pastoral system for 20+ years with improved welfare and wealth distribution for herders, less degradation to the landscape, and reduced need for emergency-based aid would be considered a successful model. This time period would cover for most pastoralist regions at least three full cycles of predrought planning, drought coping, and recovery periods. All the elements that contribute to such a successful pastoral enterprise—for instance, species and breed diversification, sustainable resource use, marketing and income diversification strategies, mobility, and flexible tenure regimes—are what should be supported by outreach programs in the future.

In this concluding section, we return to the question of what the concept of resilience contributes or adds to what we already know about pastoralist livelihoods and development initiatives. Where does it make or have the potential to make singular, unique contributions, and where does it merely complement existing concepts and approaches? We also explore the policy implications of the paper's findings. What policies build resilience in pastoralist areas, what policies have not been effective, and where should policy efforts focus? Because mobile pastoralism is often a transborder activity, the section also examines the policy-based initiatives of regional bodies. Finally, we conclude by asking what additional research and policy-based analyses are needed to better understand and improve the resilience of pastoralist households and communities.

To begin, we have argued that a focus on resilience should not replace other useful analytical concepts such as sustainability, vulnerability, and poverty traps in the analysis of pastoralism and its development challenges and opportunities. We have argued that a key indicator of drought resilience, bounce back, is useful to differentiate those who recover and those who do not recover from a weather-related shock. However, this indicator needs to be coupled with a concept like that of a poverty trap, which draws attention not just to recovery or bounce back but also to recovery to different levels of welfare. Indeed, a low level of welfare is not a condition that a household aspires to recover to and should not be an objective of development efforts.

This raises another important question: is there some level of structural constraint or poverty trap at work that explains why a subset of households at best bounce back to preexisting levels of poverty? The prevailing inequality in asset ownership indicated above suggests there are limits to the insights of resilience in the bounce back sense. Moreover, we have shown that the concept of resilience is most easily operationalized at household and community levels, but it should not mute important, underlying macroeconomic and political-economic conditions that shape the options that pastoralists face in the context of shocks and other events. While resilience importantly stresses that things should not deteriorate, we would argue that the challenge of development in pastoral areas is to ensure things improve. Perhaps this tension explains some of the variation in the definitions of resilience presented earlier in this paper. What we are aiming for is reduced poverty, improved living standards, and reduced vulnerability. Resilience has become the word that is used to capture these multiple admirable goals, but only by expanding what is contained in the concept of resilience. Our assessment is that resilience as a core concept is better viewed as one objective among others rather than *the* objective of development efforts. Resilience and growth, resilience and poverty reduction, resilience and improved livelihoods are more attractive combinations than resilience alone in pastoral development.

This overview also has shown that a significant challenge in using livestock markets to improve the resilience of pastoralists is the inopportune timing of livestock sales. Sales are highest in periods when herders need cash for food and other necessities, rather than when prices and markets are favorable. Because of the high reliance on milk production for consumption, which is largely determined by the availability of adequate pastures and feed, the need to sell animals is often driven by dairy herd production or, as discussed above, dairy herd migration. Access to feed and fodder at critical periods of shortage would go a long way toward improving pastoralists' timing of livestock sales, as well as reduce drought-induced livestock mortalities. Technical interventions in rangelands, as well as in nearby agricultural highlands in the case of Kenya and Ethiopia, to encourage fodder production and market links with the pastoral communities would be relatively low-cost options to enhance the market bargaining of pastoralists and the benefits to the local economy (SNV Netherlands Development Organisation 2012). However, these interventions, as new innovations and practices, would require research, training, and extension.

A second challenge for planners and policymakers is that while market and climate information has improved through mobile phone technologies and physical infrastructure such as roads, it remains a problem for herders. Current mobile phone technology and connectivity still favors towns over rural areas, which means that town-based traders have a considerable advantage over sellers. To learn about market conditions, including price information, herders often must also access towns where connectivity is good. At this point mobile phone technologies have been a boon for traders, who note that they are essential for their businesses, but in terms of improving trade benefits for herders, the verdict is pending (Debsu 2013). The biggest issue we see is that developing information systems is only half the challenge. It is critical and essential, but we need both accurate information and the means to act upon that information. For each piece of information, we need to map out how we expect people to make decisions that use this information to make them better off in the context of their livelihoods. If we find that supporting institutions, technologies, infrastructure, or inputs are not available to enable them to act upon information, then we have identified what the second half of the challenge will look like.

In conclusion, the paper has shown that the following development initiatives hold the promise of assisting pastoral households and communities to plan for, cope with, and recover from frequent shocks:

- *Drought cycle management.* Having a specific, feasible plan with triggers, responses, and multiple dimensions is much preferable to entering a crisis and then launching an appeal for external assistance. Droughts are going to happen in the future. Knowing this and failing to have a plan is irresponsible. A very good manual for dealing with livestock-based emergencies, such as drought, is LEGS (LEGS Project 2009), and useful NGO applications of this approach for Sudanese pastoralists can be found in Gebru and others (2013).

- *Index-based livestock insurance.* One way the developed world deals with risk is through insurance. It is likely, then, that the development of insurance products will be part of the solution in the developing world as well. The experience of the IBLI project to date indicates that we can design products that are applicable to the context of livestock producers in Africa. However, extension efforts to ensure that insurance clients fully understand the product are a major challenge that has yet to be fully addressed, and it remains an open question whether there is a viable private-sector delivery model for this product in the future.

- *Safety nets.* Safety nets in pastoral areas reflect a worldwide movement toward social protection for vulnerable populations. The challenge is to develop complementary activities so that these are not variations of the unconditional, poorly timed food aid distributions they seek to replace but, instead, are actual productive safety net programs. We suggest a useful conceptual distinction, drawing on Barrett and McPeak (2006), who pointed out the need to implement two kinds of nets: one is a safety net to prevent households from falling into poverty, while the other is a cargo net to pull people up out of poverty. Both should be in place for longer-term improvements in well-being.

- *Regional and cross-border coordination.* Given the mobility inherent in pastoral production and livestock marketing networks, pastoral systems are often poorly captured by the borders of a nation-state. Cross-border movement of people and livestock, and market activity, require formal and informal protocols at the level of the nation-state or the region, or even at the more local level, in the form of agreements between communities near borders.

- *Strengthened rural-urban linkages.* Migration, remittance income, and access to urban resources by rural populations are almost certain to grow. Urban growth is likely to take on two dimensions. One is that cities such as Nairobi, Addis Ababa, Bamako, and Dakar are already big and getting bigger. They will continue to attract migrants from pastoral areas and provide markets for pastoral products. The other is that regional towns such as Marsabit (Kenya), Moyale (Ethiopia/Kenya), Yabello (Ethiopia), Douentza (Mali), and Tambacounda (Senegal) are rapidly transforming from towns to cities. These emerging cities will provide important new niches in the local economies to help expand livelihood options in the future.

- *Education.* Pastoral populations are far behind most other populations south of the Sahara in educational attainment. This limits their ability to access higher-return occupations in the national economy. Two long-standing challenges in education in pastoral contexts are the difficulty in reconciling the need for livestock mobility with the fixed-point delivery method of education, and the lack of curriculum match between the pastoral context and course content designed for urban students or those from highland farming systems. However, these education challenges need to be met as a basic precondition for other interventions; for example, the text message system for market information assumes numeracy and literacy. These basic skills are essential and can best be achieved through appropriate training and education programs.

- *Asset and livelihood diversification.* Livestock and livestock raising are the key and will remain the key to livelihoods in pastoral areas. That said, there are only so many livestock, and only so much land on which to put these livestock. As human populations grow, there will be an increasing need to build alternative livelihood strategies around livestock production and trade in dryland areas. This strategy needs to be guided, because desperation-driven diversification strategies can undermine the livestock production system (fuelwood harvesting, charcoal production, grain alcohol production) rather than enhance it (animal fattening, input marketing, milk processing). Targeted extension, occupational training, and numeracy training could be used to move toward the more desirable kinds of diversification. Applied research for development can also likely be used to answer specific program design questions: animal fattening using what feeds in what mix, for what periods of time; what kinds of inputs are the most important for expanding production; what feasible technologies exist for milk processing and what the market is for this milk, to identify a few specific examples. Socioeconomic, animal nutrition, veterinary science, and human nutrition research all have roles to play in defining the interventions that will guide the diversification households will take up in the future.

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