Original Article

Drought Coping and Adaptation Strategies: Understanding Adaptations to Climate Change in Agro-pastoral Livestock Production in Makueni District, Kenya

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Abstract Using drought as a lens, this article analyses how agro-pastoralists in Makueni district, Kenya adapt their livestock production to climate variability and change. Data were collected from a longitudinal survey of 127 agro-pastoral households. Approximately one-third of the households have inadequate feeds, and livestock diseases are major challenges during non-drought and drought periods. Agro-pastoralists' responses to drought are reactive and mainly involve intensifying exploitation of resources and the commons. Proactive responses such as improving production resources are few. Poverty, limited responses to market dynamics and inadequate skills constrain adaptations. Many agro-pastoralists' attachment to livestock deters livestock divestment, favouring disadvantageous sales that result in declining incomes. To improve adaptive capacity, interventions should expose agro-pastoralists to other forms of savings, incorporate agro-pastoralists as agents of change by building their capacity to provide extension services, and maintain infrastructure. Securing livestock mobility, pasture production and access is crucial under the variable social-ecological conditions.

En se servant de la sécheresse comme point de départ, cet article analyse comment les agro-pastoralistes du district de Makueni au Kenya adaptent leurs moyens de subsistance à la variabilité et au changement climatiques. Il s′appuie sur des données issues d′une enquête longitudinale auprès de 127 ménages agro-pastoraux. Environ un tiers des ménages ont des animaux mal nourris, et l′état de santé du bétail est un problème majeur aussi bien en temps de sécheresse qu′en absence de sècheresse. Les actions adoptées par les éleveurs en réponse à la sécheresse sont réactives et consistent essentiellement en une intensification de l′exploitation des ressources et des biens communaux, et peu en des mesures pro-actives telles que l′amélioration des ressources de production. La pauvreté de ces populations, leurs réponses imparfaites aux dynamiques de marché et leur manque de compétences limitent leur capacité d′adaptation. Le fort attachement de nombreux éleveurs au bétail les empêche de se désengager de l′élevage; ceci mène à des ventes de bétail défavorables aux éleveurs et entraîne un déclin de leurs revenus. Afin d′améliorer leur capacité d′adaptation, des interventions devraient être entreprises pour exposer les agro-pastoralistes à d′autres formes d′épargne. En outre, la capacité des éleveurs à fournir des services de vulgarisation agricole et à maintenir les infrastructures doit être développée. Dans un contexte de variabilité socio-écologique, il est crucial d′assurer la mobilité du bétail, ainsi que la production de pâturages et leur accessibilité.

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Introduction

This article analyses drought coping and adaptation strategies as a proxy for understanding levels of preparedness for climate change in agro-pastoral livestock production. As an increase in climate variability is a likely outcome of climate change in Africa, adaptability to drought can provide insights into adaptation to climate change.

With this focus, this article contributes knowledge on coping and adaptation strategies in a context of biophysical and socio-economic resource scarcity, which might worsen with climate change. Although some of these strategies have been described in the literature, few studies explore the implications of climate change for such production systems and their potential adaptation responses.

Climate change, including climate variability, is a major driver of changes in livestock production through impacts on ecological conditions, in particular on pasture growth and quality and on the availability of water resources, as well as on the distribution of livestock diseases (RoK, 2002). Climate change, that is, change in climate over time, whether in average weather or extreme events (cf. IPCC, 2007a), is already altering known climate variability in Africa by increasing both temperatures and the frequency and severity of extreme climate events and decreasing rainfall reliability (Christensen *et al*, 2007). In some African regions, increased rainfall and decreased temperatures have also been observed (cf. Hulme *et al*, 2001).

Africa is highly vulnerable to climate change owing to the magnitude of projected climate change and the limited capacity in Africa to adapt to its impacts. Christensen *et al* (2007, p. 866) state that warming throughout Africa and in all seasons is 'very likely[1] to be greater than the global annual mean warming, with drier subtropical regions warming more than the moister tropics'. Projections from general circulation models indicate median temperature increases towards the end of this century of '3°C–4°C, roughly 1.5 times the global mean response' (Christensen *et al*, 2007, p. 867). Projections of future annual mean warming across Africa range from 0.2°C to more than 0.5°C per decade, whereas future changes in mean seasonal rainfall in Africa are less well defined (Sivakumar *et al*, 2005).

Mean annual rainfall in East Africa is likely[1] to increase, but this increase will not be uniform across space and time (Schreck and Semazzi, 2004; Christensen *et al*, 2007). Jones and Thornton (2009) predicted that croppers might become livestock keepers by 2050 because season failure rates in East African mixed rain-fed arid/semi-arid systems might increase from nearly 1 in 6 years to 1 in 3 years. These statements need to be interpreted in the context of uncertainty regarding global climate models, the characteristic high rainfall variability in East Africa, and the possible increases in water-related tensions owing to the combined effects of population growth and climate change (le Blanc and Perez, 2008).

Already now, the observed changes have adverse effects on agro-pastoral production systems, that is, crop farming and livestock production. Future climate change will likely increase the frequency of drought (Christensen *et al*, 2007). The possible consequences of the combination of higher temperatures and more variable rainfall could reduce crops and pasture growth, and contribute to desertification and biodiversity loss, food insecurity, and livestock loss, thus leading to higher insecurity of agro-pastoral livelihoods.

Against this backdrop, this article analyses how agro-pastoralists adapt their pastoral livelihoods to climate variability and change, and explores potential adaptations. It is based on empirical data from the semi-arid areas of former Makueni district. The study area illustrates a transition region. The semi-arid area borders semi-humid areas of higher agricultural potential and arid regions of lower potential. Most African semi-arid areas

where agro-pastoral livelihoods are currently dominant were predominantly pastoral (Tiffen *et al*, 1994). Understanding agro-pastoral livestock production in a climate change context can thus offer useful insights into the adaptation and transformation of smallholder livestock production.

Below, I will present a brief literature review, and describe the study area and the methodology. This will be followed by an analysis of agro-pastoral strategies under non-drought and drought conditions, with a discussion of the insights in terms of coping and adapting to climate change. Finally, I will explore options for increasing adaptive capacities in agro-pastoral livestock production.

Coping with and Adapting Livestock Production to Climate Variability

Over the years, agro-pastoralists have adapted to various forms of climate variability such as droughts, dry spells, delayed seasonal onsets and cessations, and heavy rainfall resulting in floods. However, projections indicate that climate change may challenge the very existence of current livestock productions systems, making transitions inevitable (Jones and Thornton, 2009).

Approximately 80 per cent of Kenya is arid and semi-arid, with pastoralism and agro-pastoralism being the dominant rural livelihoods. According to Ellis and Freeman (2004), low household incomes in Kenyan rural areas are associated with low land and livestock holdings, high reliance on food crop agriculture, and low monetisation of the rural economy. They also argue that land sub-division at inheritance, declining security in rural areas, deteriorating access to proper agronomic advice and inputs, and predatory taxation by decentralised district councils sometimes worsen these adverse conditions. While a poverty spiral traps the poor, better-off households diversify livestock ownership as well as on-farm and non-farm income sources (Ellis and Freeman, 2004).

Livestock mainly includes local breeds such as East African Zebu cattle (Mwacharo and Drucker, 2005). Moreover, the population of the small East African Shorthorn Zebu, highly appreciated for its adaptive traits, is declining. Small herd sizes and locally sourced breeding males have led to increasing inbreeding with unfavourable long-term effects on productivity (Mwacharo and Drucker, 2005).

In addition, agro-pastoralists' strategies are under severe strain owing to multiple pressures from demographic, socio-economic, governance and institutional changes (Powell *et al*, 2004; Thornton *et al*, 2009). These changes affect actors in various ways, for example, through expanding livestock markets and improving or constraining the production conditions of certain farmers (cf. Mbogoh, 2000).

There are widespread drought impacts not only on crops, but also on livestock in Kenya. Droughts are associated with deterioration of livestock, increased incidences of certain diseases and livestock deaths (Anyango *et al*, 1989), altered herd structure (Oba, 2001), and a collapse of livestock markets that reduces agro-pastoralists' and pastoralists' bargaining power (McPeak, 2004). The decline in purchasing power is a major cause of famine (Swift, 1989; Ifejika Speranza, 2006). For example, it was not food production shortfalls that caused the scarcity of food during the 1984 drought, as is often believed in famine relief. Rather, it was the failure of livestock and food markets (Sperling, 1989; Ifejika Speranza, 2006). Thus, droughts and floods in Kenya have coincided with market failure (for example, 1984/1985) and with persisting local conflicts over resources, and have occurred during political crises (for example, 2007/2008). All these non-climatic

factors interact to define the context within which climate change-induced droughts and floods impact on the population and the environment.

Although mobility is without doubt a rational and flexible strategy for using variable resources, it is an age-old strategy in the arid and semi-arid areas that has become successively curtailed by a combination of colonialism, resettlements, government policies, population growth and private ownership of land, among other factors (ibid.). The prevailing socio-political arrangements make mobility increasingly difficult as an adaptation strategy. Agro-pastoral space for livestock mobility has thus declined in the study area.

To cope with drought, agro-pastoralists implement various strategies, including increased livestock sales and movement/migration to distant pastures (Akong'a and Downing, 1985). Faced with crop failure, livestock sales offer an alternative to buffer consumption against income shocks (McPeak, 2004; Ifejika Speranza, 2006). This potential of livestock sales declines, however, in the case of households in certain low-income, high-risk environments that face simultaneous asset and income shocks (McPeak, 2004; Ifejika Speranza, 2006).

Recommendations made in the literature for improving agro-pastoral strategies include diversification in livestock mix, improving livestock marketing and transportation, organising supplementary feeding, stabilising livestock prices, destocking, ensuring mobility, and establishing slaughterhouses and restocking schemes (Anyango *et al*, 1989; Morton and Barton, 2002). However, effective implementation remains a challenge. Many agro-pastoral areas such as Makueni district continue to experience adverse effects from droughts, and local adaptive capacities are often insufficient, thereby necessitating relief food interventions, as was again the case in the recent 2008/2009 severe drought.

Methodology

The Makueni study area

Former Makueni district (recently subdivided into Makueni, Mbooni, Kibwezi and Nzaui districts) is located in southeastern Kenya between latitudes 1°35′S and 3°S and longitudes 37°10′E and 38°30′E (Figure 1). The area is inhabited by the Akambas. Most of the semi-arid areas of Makueni district were barely inhabited before 1950, when they served as grazing areas (Tiffen *et al*, 1994). People successively settled the southern parts of the district until the 1990s as the quantity of land *per capita* declined in the north. The current population is estimated at 994 375 (2008), while population density is increasing and ranges from 30/km^2 in the semi-arid southern lowlands to 607/km^2 in the sub-humid northern highlands (RoK, 2005). Areas previously used for extensive grazing or periodically fallowed are now permanent croplands.

The semi-arid area is the dominant climatic zone (63 per cent) and covers most of the lowlands in the district (Sombroek *et al*, 1982). The arid zone borders the semi-arid belt to the south and covers 13 per cent of the district. The soils are of low-to-medium fertility. Natural vegetation comprises open scrubland and dense wooded scrubland, with some grassed scrubland of perennial grasses. The predominant cover for grasslands is *Aristida spp*. (CETRAD, 2004).

The climate is tropical, with mean annual temperatures ranging from 20°C to 25°C. Major climatic drivers are the monsoons, subtropical anticyclones, the Inter-Tropical Convergence Zone (ITCZ) and the El Niño/Southern Oscillation (ENSO). Droughts, dry

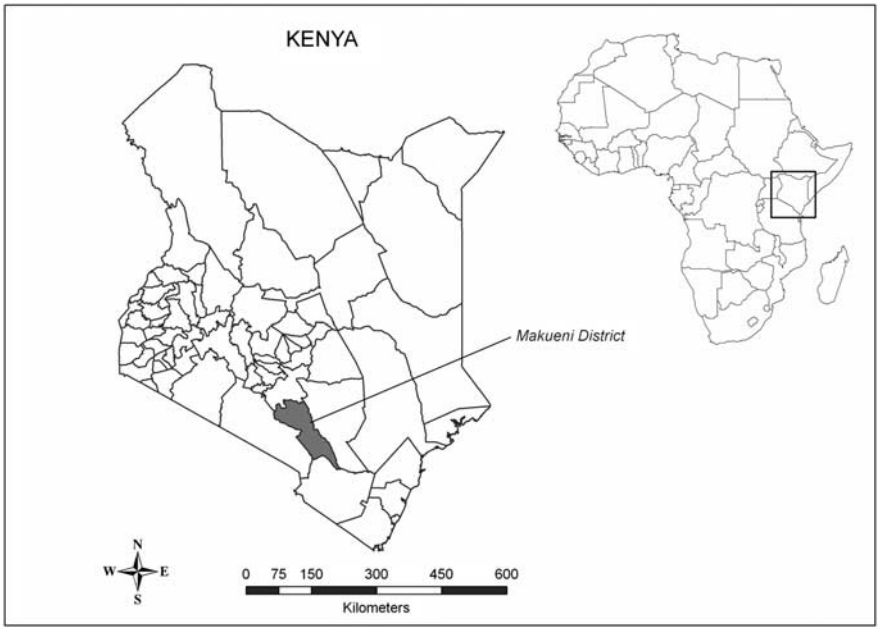

Figure 1: The Makueni district study area in the Kenyan and African context.

spells and their variability have been associated with ENSO (Ambenje, 2000). The bimodal rainfall regime of the region is associated with the northsouth movement of the ITCZ. The first rains ('long rains') occur in March/April/May (MAM). The second rainfall season ('short rains') occurs in October/November/December (OND) (Ogallo, 1994).

Rainfall onset, amounts and duration vary considerably, with droughts and dry spells recurring. The semi-arid areas receive less than 800 mm rainfall per year. The average seasonal rainfall amounts range from 120 to 240 mm (MAM) and from 220 to 410 mm (OND). Rain-fed crop farming and livestock-keeping are the major livelihoods. The semi-arid and arid areas of Makueni district are marginal environments of low agricultural potential. Subsistence agriculture comprising agro-pastoralism (crop production and livestock-keeping), nomadic pastoralism and wildlife conservancy are the major land uses. Land is mainly privately owned and agro-pastoralists are sedentary, but sometimes walk long distances to graze their livestock.

Data and methods

Both qualitative and quantitative data were collected in two surveys. The first survey conducted in 2002 focused on agro-pastoral households, their socioeconomic conditions and practices under non-drought conditions, as well as historical timelines. The second survey conducted in 2003/2004 focused on drought perceptions, drought impacts and coping strategies during the 1999/2000 drought. The same 127 households in eight villages were interviewed in both surveys (CETRAD, 2004). Additional data were obtained from expert interviews, participation in workshops and farmer field schools during this period. Having data from two surveys facilitated the analysis of agro-pastoral livelihoods and strategies in non-drought and drought periods. Additional qualitative data were

collected in 2009 using focus group discussions and expert interviews (Kiteme, 2009). Content analysis and statistics such as mean, standard deviation and *t*-tests were used to analyse the data.

Production Strategies under Non-drought Conditions, the 1999/2000 Drought Impacts and Agro-pastoral Responses

Among agro-pastoralists, livestock is the second most important source of income after crops. Major droughts covering parts of or the whole Makueni district recently occurred in 2008/2009, 2005/2006, 2004, 1999/2000, 1995/1996, 1991/1992, 1983/1984, 1980, 1977, 1975 and 1971. While this article focuses on the 1999/2000 drought, the 2008/2009 drought was even more severe. It triggered extensive livestock deaths and a famine that necessitated the Kenyan president to declare a national disaster and launch an appeal for US$400 million in foreign aid (USAID FEWS NET, 2008; IFRC, 2009; *Daily Nation Newspaper*, 2009). The major strategies adopted by households under non-drought conditions and under the 1999/2000 drought conditions are discussed below.

Managing livestock holdings under non-drought and drought conditions

Before the 1999/2000 drought, 51 per cent of households kept cattle, 91 per cent goats, 17 per cent sheep, 15 per cent donkeys, 91 per cent poultry and 17 per cent log-type beehives. Based only on those keeping livestock, a household had on average 5 cattle, 12 goats, 5 sheep, 26 poultry, 5 beehives and 2 donkeys. Households mainly own livestock of local breeds (for example, Zebu cattle), which are more adapted to the harsh semi-arid environment. The drawback is the low milk production compared to improved breeds. In local culture, owning cattle and other livestock is a sign of affluence. Many households do not keep sheep owing to their lower economic value relative to goats, the association of sheep-keeping with traditional religious practices, and the perceived non-conducive environmental conditions for sheep-keeping.

The livestock mix plays a major role in household welfare. Large stock is usually sold to deal with big problems such as paying health bills, dowry and school fees, while small stock such as goats is sold to take care of smaller problems such as paying school levies, purchasing farm inputs and domestic items. Agro-pastoralists spread the risks of diseases and droughts by holding different livestock types. Those with a large herd reduce these risks by splitting their herds into sub-herds that graze in different areas, while those with smaller herds give livestock in custody to relatives living elsewhere. Women can only exclusively exercise their ownership rights with poultry, which is a major income and food expenditure source for them. In contrast, women cannot sell goats and cattle without permission from their husbands or unaccompanied by male relatives. Therefore, the higher the number of poultry in a household, the higher the capacity of women to obtain money through poultry sale.

The 1999/2000 drought adversely affected livestock holdings mainly by triggering livestock sales (76 per cent) and contributing to livestock deaths (52 per cent). However, there were also livestock births in 44 per cent of households. Other reasons for changes in livestock holdings were purchase and sale patterns (9 per cent), consumption and theft. Although 15 per cent of households experienced wildlife attacks on livestock, only

2 per cent reported livestock loss owing to wildlife predation. Hyenas and jackals increased attacks on goats, while fox, hyenas, mongooses and hawks predated on poultry.

Livestock holdings generally decreased after the drought, especially cattle, goat and poultry holdings. Using the paired sample test (*t*-test), the reduction in livestock numbers before and after the drought for those keeping livestock was significant for cattle, goats and poultry (Table 1). While the mean numbers of sheep and of beehives remained the same, those for all other livestock, that is, cattle, goats, poultry and donkeys, were lower than before the drought.

Responding to drought can be in the form of preparedness strategies or *ad hoc* (reactive) responses when drought occurs. In terms of preparedness, 50 per cent implemented measures to protect their stock from drought impacts whereas 48 per cent did not. The main preparedness strategies are preserving pastures and storing adequate feeds (39 per cent), stocking drugs for treating animals (2 per cent), de-worming healthy stock, and praying to God (1 per cent).

Faced with various impacts in the 1999/2000 drought, households responded with multiple measures. While some treated the sick livestock (29 per cent), others did nothing (26 per cent), another 26 per cent restocked through purchase of livestock, 11 per cent waited for the livestock to breed, 2 per cent prayed to God, 2 per cent planned to store feeds to cope with future droughts, 1 per cent hired pastureland, and another 1 per cent stored enough food so there was no need to sell livestock to buy food. Those whose livestock were stolen during the drought increased security.

Managing land holdings, pastures and livestock feeds

The average land holding per household is 12 acres (5 ha), out of which 5 acres (2 ha) are used for crop cultivation while 6.3 acres (2.5 ha) are set aside for livestock grazing and browsing. While access to land is important, land management is equally crucial for sustaining livestock production.

Table 2 shows that free grazing and combinations of free grazing and tethering are the main practices. Controlled grazing is not widespread. Tethering achieves various aims, such as protecting crops from livestock and reducing the roaming of livestock, and provides some security against theft. Pasture and forage mainly include indigenous grass and palatable shrubs (Jaetzold and Schmidt, 1983). Approximately 79 per cent of households set varying sizes of pastureland aside for grazing while 20 per cent had no pastureland. While 22 per cent partitioned their pastures into portions for grazing at different times to ensure pasture adequacy, 58 per cent let livestock roam the entire pastureland. Cattle, donkeys, goats and sheep were either tethered or grazed freely, depending on field ownership and security conditions. In addition to their own pasturelands, households also grazed their livestock on common lands or on unsettled plots. Livestock also fed on crop residues, while very few households (2 per cent) hired pastures for cattle or purchased feeds (1 per cent) for poultry as primary sources of feeds.

In non-drought periods, 47 per cent of livestock owners found the pastureland to provide adequate feeds for their livestock whereas 28 per cent did not. During the drought, 44 per cent stated that their pastures fulfilled the grazing needs of their livestock, while it was considered inadequate by 50 per cent. Table 3 illustrates the various ways in which agro-pastoralists negotiate access to pastures. One household even rented pastures from a neighbour in exchange for labour for ploughing in the next season.

Table 1: Paired sample test (*t*-test) of changes (reduction) in livestock numbers before and after the 1999/2000 drought

	N	*Paired differences*					*t*	*df*	*Sig. (2-tailed)*
		Mean	*SD*	*SE mean*	*95% Confidence interval of the difference*				
					Lower	*Upper*			
Pair 1									
Number of cattle before drought Number of cattle after drought	58	1.07	2.707	0.355	0.36	1.78	3.007	57	0.004
Pair 2									
Number of sheep before drought Number of sheep after drought	17	−0.29	2.687	0.652	−1.68	1.09	−0.451	16	0.658
Pair 3									
Number of goats before drought Number of goats after drought	103	4.07	7.918	0.780	2.52	5.62	5.214	102	0.000
Pair 4									
Number of poultry before drought Number of poultry after drought	103	11.75	21.143	2.083	7.62	15.88	5.639	102	0.000
Pair 5									
Number of donkeys before drought Number of donkeys after drought	18	0.28	0.958	0.226	−0.20	0.75	1.230	17	0.236

Table 2: Modes of feeding livestock

Feeding practices	*Cattle (%)*	*Goats (%)*	*Sheep (%)*	*Donkeys (%)*
Free grazing	33	50	12	6
Free grazing/Tethering	10	21	3	4
Tethering	6	20	2	3
Controlled grazing	1	2	—	—

Source: Own fieldwork.

Table 3: Coping with inadequate pastures under non-drought and drought conditions

Livestock feeding sources	*Non-drought period (%)*	*1999/2000 drought (%)*
Hired/purchased pasture	17	21
Grazed in cropland	7	4
Fed on maize and cowpea residues	6	6
Fed on hay	1	—
Destocked	1	—
Grazed along riverbanks, on unsettled plots, neighbours' pastures, borrowed pasture, game reserve and government farm	—	20
No supplementary grazing	—	6
Grazed on other lands with owners' permission free of charge	—	2

Source: Own fieldwork.

A comparison of household practices in non-drought and drought periods (Table 3) indicates that agro-pastoralists had already used the same strategies before drought occurred, but intensified the use of the commons during droughts. This means that inadequate pastures remained a problem for the 28 per cent already supplementing pastures under non-drought conditions. Additionally, the amount of maize stalks kept for livestock could be increased, but this is impossible without extending the cropland. The drought also adversely affected crop production, thereby reducing the quantity of crop residues for fodder.

Faced with these limitations during the 1999/2000 drought, 66 per cent of households took precautionary measures to ensure future pasture supply. Approximately 11 per cent took no measures, while one household was constrained owing to unclear land ownership. As pastures are scarce during droughts, 41 per cent of households spent more money or time to obtain feed and water for livestock by walking longer distances in search of both resources. Those who experienced no increase in time or money to access pasture and water attributed this to having stored enough feed for livestock (40 per cent), owning a small number of livestock (13 per cent), and practising free grazing along rivers and in unsettled lands (4 per cent), while 1 per cent borrowed pastures.

Water resources and coping with water scarcity

Water is a scarce resource in the district and a major livelihood constraint. Apart from rainfall, rivers, springs and dams provide surface water. The district has a few perennial rivers, most of which drain into the Athi River. Other perennial rivers only have

sub-surface flows during the dry season so that people have to dig shallow wells in the riverbed to fetch water. Groundwater is unevenly distributed owing to varying rock formations, and is often saline. However, it remains the principal source of water for those settlements without any streams or rivers nearby.

The majority of households collect their water mainly from rivers and streams. These are on average 2.5 km away from the homesteads. Most water sources are seasonal and 43 per cent of households attribute this seasonality primarily to drought and delayed rains. However, other factors such as overuse, destruction of water catchment areas and the associated silting also cause water sources to become seasonal.

Table 4 shows that rivers and streams remained the main water sources for livestock, although livestock had to be walked longer distances to other rivers. Other sources included springs, boreholes and shallow wells. Those who watered their livestock at home did so mainly to avoid cross-infections. The average distance to water sources for livestock increased to 5 km and the time spent at the water source increased, leading to a reduction in water available for intake by livestock.

Livestock diseases and treatment

Under both non-drought and drought conditions, the high prevalence of pests and diseases is a major concern. Households perceived the prevalence to increase during the 1999/2000 drought. Although households admitted that diseases could occur at any time, they maintained that the diseases occurred mainly during the dry season and during droughts. Diseases affected the livestock of 72 per cent of households during the drought. Cattle were affected in 35 per cent of households, mainly owing to respiratory infections (22 per cent), East Coast Fever (ECF, *kithatia;* 6 per cent), foot-and-mouth disease (*muthingithu*; 5 per cent), skin infections (2 per cent) and worms and parasites (2 per cent). Other diseases were trypanosomiasis (*kisiko*) and gland and liver infections. Households linked every disease to diverse causes. For example, they attributed cattle respiratory infections to ticks, dust, contaminated pastures, dirty water, dry pastures and cross-infections. ECF was attributed to ticks, feeding on nylon bags and sand, and lack of water. It turned out that 14 per cent did not know the true causes of the diseases affecting their cattle. There is therefore a need for information and knowledge dissemination regarding the causes of livestock diseases and their prevention.

Sheep suffered mainly from worms (2 per cent), respiratory infections (2 per cent), diarrhoea and mumps (1 per cent). The diseases were attributed to consumption of contaminated feeds, dust and hunger. In 55 per cent of households, diseases affected goats; they included coughs and lung infections (44 per cent), worms and parasites (6 per cent), diarrhoea (5 per cent) and liver infections (2 per cent). Bloat, bile-related diseases and

Table 4: Water sources for livestock during non-drought and drought periods

Water sources	*Non-drought period (%)*	*1999/2000 drought (%)*
Rivers or streams	54	57
Homestead	31	10
Dams and water pans	10	10
Piped water	6	—
Water holes	6	—

Source: Own fieldwork.

swollen lymph nodes were also mentioned. While 29 per cent did not know the causes of the diseases, 16 per cent believed that dust caused lung infections. Other causes proffered by households included ticks (4 per cent), contaminated feeds (3 per cent) and contaminated water (3 per cent), cross-infection, poisonous shrubs, tsetse flies and worms. Diseases affected donkeys in 5 per cent of households. They included worms, gastro-intestinal and respiratory infections.

Diseases affected poultry in 57 per cent of households: mainly coughs and lung infections (26 per cent), coccidiosis (14 per cent), liver infections (11 per cent) and diarrhoea (6 per cent). Other diseases were Newcastle, eye infections and bile-related diseases. While 37 per cent of households did not know the cause of the diseases, 13 per cent attributed them to dusts and winds. Other causes identified included bacteria and viruses, contaminated feeds and water, cross-infection and cold weather.

Apart from diseases, 21 per cent of households mentioned other effects of the 1999/2000 drought. These included increased livestock deaths, reduced fertility and breeding owing to insufficient feeding, reduced livestock production, flea infestations and retarded growth. Agro-pastoralists identified diseases as the major cause for livestock deaths during the drought. Approximately 23 per cent of households experienced cattle deaths, 39 per cent goat deaths and 45 per cent poultry deaths.

Household measures against livestock deaths included treating sick animals (19 per cent), improving livestock husbandry, for instance by de-worming (10 per cent), stocking drugs to treat livestock in case of disease (3 per cent), consulting veterinary officers (2 per cent) and watering livestock at home to avoid cross-infections. However, 51 per cent took no precautionary measures.

Faced with livestock diseases during the drought, 64 per cent of households responded in various ways to keep their livestock healthy. However, because of high poverty levels and limited livestock services, 52 per cent of households treated their livestock themselves, using either traditional herbs or conventional drugs bought at a market. While 26 per cent did nothing, 14 per cent consulted veterinary officers or village para-veterinarians, 5 per cent conducted regular preventive treatments and 2 per cent restricted contact of their livestock with other herds. It is worth noting that 3 per cent sold their sick animals at a market, a way of spreading a disease should it be infectious. Further, 75 per cent of households applied acaricides on livestock, with 41 per cent treating their cattle and 75 per cent their goats. Some households used products (registered trademarks) such as Triatrix®, Karate®, Amatox®, Steladon®, Tacktik® and Ka-seven®. Others took their livestock to the dips while they treated poultry with 'poultry dust'. Some 14 per cent of the households that did not use acaricides, despite livestock infections, reported that they could not afford to buy such products.

Approximately 35 per cent of households consulted extension services during the drought to treat sick livestock (28 per cent), to vaccinate livestock (7 per cent) and to de-worm livestock, while others received advice on how to control livestock diseases and administer drugs. For 73 per cent of households the main support they needed was information on disease symptoms, prevention, treatment and cure, while 12 per cent mentioned general livestock management and proper feeding especially during droughts.

Access to markets and sale of livestock as a drought coping strategy

After crops, livestock is the second key source of income for most agro-pastoralists. Income from livestock also grows in significance as incomes from crops decline. Thus,

livestock sale is an insurance buffer – a security against income loss owing to crop failure (Ifejika Speranza, 2006).

Of importance to households is access to markets, to sell their crops and livestock, and to buy non-farm commodities as well as food. Thus, proximity and specialisation influence decisions regarding market use. Access to markets depends on an intricate combination of road conditions, transport availability, market size and the stability of prices. Generally, the earth roads are difficult to navigate in the wet season, and swift currents rushing over the low-lying bridges sometimes carry away vehicles and people during heavy rains. Therefore, it is more difficult for villagers to access bigger markets during the rainy season.

The major livestock markets used by households are Makindu, Kalawa, Kathonzweni and Kyanginywa. In contrast to crops, very few households sell livestock at the farm-gate. Livestock is transported to the markets mainly on foot (79 per cent). Some households use bicycles (3 per cent) or go either on bicycles or on foot (2 per cent).

When farmers sell their crops, they usually buy livestock as a form of savings to draw upon in times of need. Livestock prices are generally high when grain prices are low, but many households do not take advantage of this situation. This is because livestock is the major form of savings and divested only in case of major household problems. Livestock prices are thus higher during the rainy season than during the dry season. In February/March, grain is abundant and the need to sell livestock is low, and thus livestock prices are high. From October until December, the demand for oxen is high because they are used to plough. Livestock prices are lowest in January, May and September, when households need money to pay school fees.

Having livestock to sell during droughts is thus a major form of insurance and a key precautionary strategy for many agro-pastoralists. As some agro-pastoralists put it, 'livestock are kept to be sold during drought', so the main impact of drought on livestock sale is an increase in sales compared to normal times and unintended sales rather than sales *per se*. Another impact is the low market price for livestock during drought. Livestock sale is the most readily available means to generate cash for contingencies; consequently, it decreases a household's asset base, as livestock remains the principal agro-pastoral asset aside from land and crops. Preparedness measures against future drought impacts include reducing livestock sales, by exploring alternative income sources, preserving food, increasing cropland, utilising stored food carefully and diversifying crop production by including fruit production.

At the beginning of the drought, 54 per cent of households were selling mainly goats and poultry to earn cash to buy food; by the end of the drought, only 33 per cent still sold livestock. During the drought, households sold more livestock than during comparable non-drought periods. Thus, 69 per cent of households reported increased sales compared with normal periods. This difference in the level of sales is significant for cattle. Although households sold more poultry and donkeys during the drought, this increase in sales was not significant, because under normal circumstances women often sell poultry to earn cash to meet household needs. Under drought conditions, some households choose, or are compelled, to consume their livestock instead of selling them for cash owing to lower prices. This was the case for 21 per cent of households, which increased their meat consumption during the drought compared to non-drought times. While the prices of crops increase during drought, the opposite is the case for livestock prices: they plummet as drought advances. For example, mean and median bull prices during non-drought were 15 269 Kenya shillings (KSH; ca. US$204 using US$1 = KSH 75) and KSH 15 500 (US$207). During the 1999/2000 drought, the prices fell to KSH 8787 (US$117) and KSH

9250 (US$123), respectively. Similarly, mean and median goat prices under non-drought conditions were KSH 1256 (US$17) and KSH 1200 (US$16). During the drought, prices fell to KSH 659 (US$9) and KSH 600 (US$8), respectively. This decline in livestock prices in times of drought is significant, and can be as much as 45 per cent below non-drought prices for cattle, sheep, goats, poultry and donkeys, but not for beehives.

Apart from livestock itself, households also sold milk, eggs and honey. However, production of milk and eggs decreased during the drought, putting an end to the market for livestock products. While livestock sales alleviate drought impacts by increasing access to cash, their effectiveness depends on the markets and on drought duration as livestock assets rapidly deplete. The decimated stock is rebuilt after drought. This implies that the frequency of drought defines, to a certain extent, the frequency of stock divestment, and in effect lowers households' assets and their capacity to cope with future droughts.

Two years after the drought, 51 per cent of households had recovered their livestock losses while 40 per cent had not. While 12 per cent restocked within less than a year, 28 per cent recovered livestock numbers after 1 year and 13 per cent after 2 years. Restocking methods included natural breeding (82 per cent) and purchase (48 per cent).

Insights for Climate Change Adaptation from Responses to Drought Impacts

Drought affects livestock production through a deterioration of production conditions and livestock conditions, as well as livestock exchange conditions (Table 5). These impacts are additional to those on crop production in agro-pastoral systems.

Table 5 presents agro-pastoralists' responses to drought. However, it is important to know how sustainable such responses are, especially in supporting adaptation options. Table 5 shows that most households respond reactively and *ad hoc* rather than proactively. Although they set aside pastureland for livestock, very few take further measures to ensure pasture availability, for example by partitioning the pastureland or by improving the quality of pastures. While agro-pastoralists use various pasture sources such as common grounds or protected areas, these resources are not enough to sustain livestock production under prolonged or frequent droughts. Grazing on government land presumes that access is not restricted although it actually is. Should government enforce access restrictions, more agro-pastoralists would have inadequate pastures to graze livestock during drought periods.

Ifejika Speranza *et al* (2010) show that agro-pastoralists possess indigenous knowledge (IK) on indicators of rainfall variability (as a proxy for future pasture conditions) and believe in their efficacy. While they also consult meteorological forecasts, only a few adapt their practices accordingly, which is partly a result of their conditioning to the high rainfall variability characteristics of the area and partly a result of resource constraints. The limited intergenerational transfer of IK currently threatens its further existence (Ifejika Speranza *et al*, 2010).

Droughts continue to affect Makueni district almost every year, and the district remains among those that receive emergency relief food and other interventions. Thus, fundamental changes are needed to build the resilience of agro-pastoral livestock production. The semi-arid context indicates fragile pasture conditions and variable access to pastures and water. The increasing human and livestock populations intensify pressure on the fragile and degraded resources, which climate change might exacerbate.

Table 5: Drought-related impacts on livestock production and agro-pastoralists' responses

Impacts on livestock production	*Coping/adaptation strategies*
Deteriorating production conditions	
Water shortage/lack of water	Walk longer distances with herd to access water
	Dig shallow wells in river beds
	Purchase water
	Water livestock at home
Shortage of pastures/forage; lack of pastures	Intensify grazing in common pool resources
	Migration/walk longer distances with herd to access distant pastures
	Graze livestock in protected areas/on government lands
	Give livestock to kin
	Destocking
Increase in livestock theft	Increase security
Increased predation by wildlife	Increase surveillance and security
Deteriorating livestock conditions	
Weight loss	Increase supplementary feeding
Production loss	
Reduced breeding/reproduction	
Reduced milk/egg/honey production	
Increased incidence of certain livestock diseases	Treat sick stock
	Consult livestock extension officer and para-veterinarians to treat livestock
	Sale at local markets
Livestock deaths	Restock through purchase
	Wait for surviving livestock to breed
Unfavourable exchange conditions	
Declining livestock prices	No measures
(Forced) sale of livestock	
Reduced income from livestock	

Source: Own fieldwork.

Pathways to Improving Coping and Adaptation in Agro-pastoral Livestock Production

Although climate variability and climate change are major drivers of change in livestock production, other factors such as poverty and lack of adaptive capacity are also important. Multiple measures are thus needed to secure future agro-pastoral livestock production. These include improving the social-ecological production conditions, and improving access to grazing resources, veterinary medicine, extension services and markets.

Training locals as para-veterinary officers to treat diseases that do not require the expertise of a veterinary doctor can improve access to livestock health services. Such para-veterinary officers can also serve as network nodes for a district veterinary doctor in diseases surveillance. By training locals in livestock extension, the knowledge remains

with the local people and such a model reduces the dependence on extension officers who are not only few, but are also periodically transferred to other localities. While there are still some policy issues on developing standards for Community-based Animal Health Workers (CAHWs) and on developing ways to verify their professional skills and ethics (cf. RoK, 2008, pp. 27, 52), Cinnamond and Eregae (2003) found that more than half of the pastoralists in West Pokot, Marsabit and Wajir had received treatment from CAHWs for their livestock. In response, the Kenyan government, in its draft dairy industry development policy (RoK, 2007a, pp. 20, 38), plans to 'amend the Veterinary Surgeons Act to allow para-veterinary workers with diploma and certificate training to treat animals'.

This article shows that short-distance mobility is a crucial agro-pastoral coping and adaptation strategy. Thus, under prevailing socio-political circumstances that constrain mobility, agro-pastoralists need to maintain existing negotiated access to pastures. However, with population growth and without a shift of labour to other sectors and should absentee land owners develop their lands, agro-pastoralists are likely to have less mobility space in future if relevant policy interventions are ignored. Such policy interventions should focus on supporting skill development that enables agro-pastoralists to enter other economic sectors, supporting locals to negotiate access to or purchase unproductive lands and encouraging rainwater harvesting and resources conservation.

Pasture can be conserved in enclosures to be used by livestock in times of scarcity. Such practices are still not common in Makueni district, although many households would have the land required. Other complementary measures such as fodder production, reduced free grazing or possibly zero grazing might be necessary not only for maintaining production, but also for improving productivity. Agro-pastoralists can be mobilised to team up with peers and build enclosures for fodder production through existing self-help group work mechanisms. Considering the uncertainty in climate change projections highlighted above, rainfall for a certain period might increase rather than decrease. This might encourage agro-pastoralists to increase their herds. Such a strategy might be profitable during a wet period, but it might lead to higher livestock losses should the trend be reversed. It might also make it easier to shift to zero grazing, that is, if livestock numbers are not greatly increased.

This would require an intensification of livestock production and a possible shift to grade animals that produce more milk or meat. However, intensification through investing in grade cattle might raise livestock vulnerability to increasing temperature as exotic grade animals are not well adapted to heat stress and drought compared to the local Zebu cattle (cf. Thornton *et al*, 2009). The costs of supplementary feeding can also be a major drawback to intensification (Moritz, 2008). However, milk sales could provide agro-pastoralists with regular income, but intensification requires that markets (for example, nearby urban centres), support structures and support services function.

If climate change intensifies and if population density increases, the already limiting conditions might lead to a further sub-division of agro-pastoralists' lands. Agro-pastoralists may have to shift to zero grazing, which is already the case in the intensified systems of the highland Makueni district. Considering that droughts might become more severe and frequent, controlled grazing provides buffers in periods of pasture scarcity.

Sustained access to water is crucial to secure livestock production. This can be achieved by harvesting runoff and accessing groundwater. However, improvement in water infrastructure has to go hand in hand with building local capacity for maintaining the infrastructure. Further studies are also needed on tropical livestock water requirements

under increasing temperatures, as the current coping strategy of agro-pastoralists to reduce the water intake of livestock may not augur well for crossbreeds that produce more milk but are less adaptable to high temperatures.

The predation of livestock by wildlife is a problem that calls for consultation of policymakers and stakeholders at relevant levels. Individually and owing to power differentials, agro-pastoralists are unable to assert their rights to compensation. While it is against the law to kill wildlife in Kenya and the law makes provision for compensation of damage by wildlife, agro-pastoralists hardly demand such compensation because they do not know the modalities involved. Community-Based Organisations (CBOs) with support from development cooperation can table this issue with the relevant government authorities, as well as with the wildlife park authorities.

Using mobile telephones can help to address livestock thefts. Agro-pastoralists in a similar region, Laikipia district, report that since they started using mobile telephones to report missing livestock to other villagers and to the police, most livestock initially stolen have been recovered before leaving the vicinity (own fieldwork, 2009). This could be a strategy for the Makueni agro-pastoralists, as mobile telephones are also widespread in Makueni rural areas. A CBO or government livestock extension service could obtain more information from the Laikipia area, where this strategy has been successful.

Unfavourable exchange conditions worsen agro-pastoralists' pecuniary circumstances. Having to sell livestock below value and on a large scale during droughts is a situation that requires government interventions and the improvement of agro-pastoralists' self-organisation. Several points need to be addressed: the cultural attachment to livestock and sticking to livestock until its value depreciates; the provision of innovative rural financial services that offer agro-pastoralists alternatives to savings in terms of livestock only; and ensuring agro-pastoralists' access to existing market information services. CBOs could identify and work with role models from the community who have diversified their assets base in order to demonstrate to the community that other forms of savings are equally prestigious and financially rewarding. As trust between villagers is low owing to past experiences, livestock extension services and CBOs need to be supported in encouraging agro-pastoralists to form livestock marketing groups in order for them to gain more control over market exchanges.

Drought renders livestock production vulnerable to both asset and income shocks (cf. McPeak, 2004). To reduce this twofold risk exposure and to promote savings, the Kenyan government could encourage financial, credit and insurance institutions to extend their services, or to speed up their expansion, to the rural areas. While this may not be profitable in financial terms, the government could provide incentives such as tax exemptions or publicity that improve the social image of participating institutions. The current use of mobile telephones to provide certain rural financial services needs to be further explored.

The high rainfall variability manifested in recurrent droughts and floods challenges livestock production in Makueni district (Ifejika Speranza, 2006). As highlighted above, major droughts have occurred in 7 out of 30 years (1980–2010; minor events not considered), some only 3 years apart. Already now, the district is a target of drought-triggered humanitarian interventions. Moreover, only half of the households had recovered their losses within 2 years after the 1999/2000 drought. The recent 2008/2009 drought is estimated to have caused unprecedented livestock losses. Considering the losses and the interventions, it seems that drought has already begun to tip the system, but in a gradual manner. This gradual change is attributable to the more or less constant

governmental and non-governmental humanitarian interventions, and also to the recent mobilisation of the Kenyan civil society and private sector for humanitarian interventions after the 2008/2009 drought. Thus, in the near future, a collapse of the agro-pastoral production system seems unlikely, also because of households' diversification strategies that tend to stabilise the production system, even if, in many cases, they do not lead to increased productivity. Successful diversification is also dependent on rural industries, urban development and the availability of jobs in the urban areas, meaning that if rural-urban migrants do not find jobs in the urban areas, the adaptive capacities in agro-pastoral production will decline owing to decreases in remittances. Furthermore, if the frequency of one drought in 3 years continues, it might push the very poor without non-farm incomes out of agro-pastoral production to the urban areas in search of menial jobs. Those who already have non-farm incomes will likely reduce their investments in the agro-pastoral system while waiting for better conditions. Those wealthy and skilled enough to survive the scarcity period might use the opportunity to acquire more land and livestock resources. Thus, an increase in drought frequency might lead to structural changes in the number of people employed in the sector and the number of migrants to nearby urban areas, to an increase in the size of land holdings for those few who are better off, and to increased social disparities.

The Kenya draft national livestock development policy (RoK, 2008) and the Kenya Vision 2030 (RoK, 2007b) generally provide for enabling conditions for agro-pastoralists to maintain their livelihoods, and they address various issues relevant to improving livestock production under adverse climatic conditions. The recent establishment of a Ministry of Livestock Development in 2008 highlights the importance attached to the livestock sector. The attempts to resuscitate various government schemes, like the Kenya Meat Commission, to buy meat from agro-pastoralists and pastoralists may reduce their exposure to drought impacts, but success is uncertain as this process is still in its infancy and past records of such schemes have been rather discouraging. Implementation remains a challenge owing to mismanagement, limited government resources and insufficient local participation.

Without these proposed changes in livestock production, the status quo (low production, high exposure to climate and disease risks, limited extension services) will remain, and might worsen with climate change.

Conclusion

Droughts are common in Kenya and are likely to increase in severity and frequency with climate change, despite the projected increases in annual mean rainfall towards the end of this century.

Insights for adaptation to climate change were derived using drought impacts and agro-pastoral coping strategies as illustrative examples. Agro-pastoralists' responses to drought are rather reactive and mainly intensify exploitation of existing resources, while comprising fewer proactive measures such as improving livestock production resources. While droughts are 'normal' occurrences, which agro-pastoralists have successfully coped with in the past, climate change might alter the frequency and severity of droughts. Drought reduces the synergies between crop and livestock production. With the prospect of more frequent and severe droughts in interaction with increasing human and livestock population density, the current impacts hint at the inadequacy of agro-pastoral strategies,

not just in terms of agro-pastoralists surviving in the long term with their livelihoods intact, but also in terms of making development progress.

While poverty and inadequate skills limit responses, attachment to livestock deters agro-pastoralists from divesting livestock in periods of favourable market conditions. Interventions to improve agro-pastoral adaptive capacities should encourage agro-pastoralists to diversify into other forms of savings, improve their access to market information and rural financial services, and identify role models.

Such interventions should not just treat agro-pastoralists as recipients, but should make them agents of change by providing for their active participation in the rendering of extension services and in maintaining rural infrastructure. If conditions for growing crops become more unfavourable owing to severe droughts, shifts in production may become necessary, whereby livestock would gain more weight relative to crops in agro-pastoral livelihoods. This would require changes in management practices such as the use of enclosures, growing fodder to ensure pasture production and negotiating for more mobility space.

More frequent and severe droughts might also increase social disparities, forcing poorer agro-pastoralists out of the production system and providing wealthier agro-pastoralists with opportunities for wealth accumulation. Policies need to support potential dropouts to acquire skills that enable them to earn an income in the non-primary sectors.

Finally, there are some limitations to using adaptation to drought as a proxy for exploring adaptation to climate change, especially considering the expected increase in drought frequencies. If droughts occur more frequently, the recovery periods will become shorter and shorter, leaving less room for recovery.

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Note

1. According to the IPCC (2007b) guidelines: 'likely' means >66 per cent probability; 'very likely' means >90 per cent probability.

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