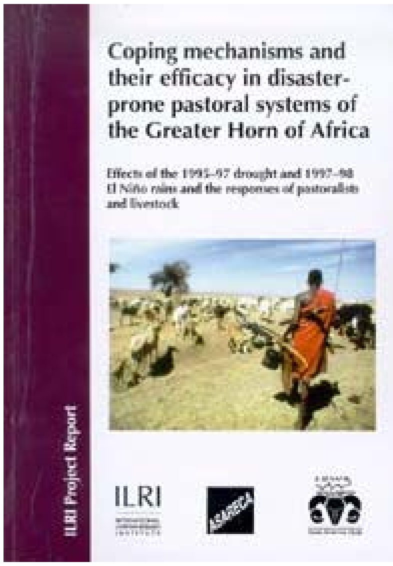
Coping mechanisms and their efficacy in disaster-prone pastoral systems of the Greater Horn of Africa



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Effects of the 1995–97 drought and the 1997–98 El Niño rains and the responses of pastoralists and livestock

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Foreword

One of the priorities identified by the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) for collaboration within the frame- work of the ASARECA-Animal Agriculture Research Network (A-AARNET) is the development of early warning systems and interventions to deal with crisis situations affecting pastoral communities in the Greater Horn of Africa (GHA).

In order to address this, A-AARNET has developed a project proposal 'Crisis mitigation in livestock systems in the Greater Horn of Africa: from relief to development' aimed at establishing a network of monitors who will provide information on and analysis of the situation of the livestock sector in pastoral areas of the GHA and formulate recommendations for interventions to mitigate the adverse effects of crises on the herds and pastoral communities' welfare. The current phase of the Crisis Mitigation in Livestock Systems Project is funded by the United States Agency for International Development Office of Foreign Disaster Assistance (USAID/OFDA).

The first requirement for effective response is timely, accurate and reliable advance information on impending crisis situations. Developing a means of getting such information is the principal feature of current activities which are carried out by A-AARNET scientists in collaboration with the Global Livestock-Collaborative Research Support Program Livestock Early Warning System (GL-CRSP LEWS) involving a team of Texas A&M University (TAMU) scientists led by Dr Paul Dyke and Prof Jerry Stuth.

Pastoral societies have accumulated wisdom and developed sophisticated means of coping with the vagaries of weather, disease and civil strife. But, these are becoming increasingly ineffective because of growing populations expanding on fixed land areas and the encroachment of cultivators and others on traditional grazing land. Thus, new responses need to be developed. In order to avoid the repeat of past failures, it was felt that the first phase of the Crisis Mitigation in Livestock Systems Project should focus on obtaining a greater understanding of the coping mechanisms of the affected societies in order to determine ways of harnessing ethnic responses and reinforcing them with appropriate measures for more efficient crises management.

The coping mechanisms in livestock systems study was therefore designed to provide baseline information about what pastoralists usually do to sustain themselves and their livestock in crisis situations through a thorough investigation of the effects and responses of pastoralists and livestock during the 1995–97 drought and 1997–98 El Niño rains in pure pastoral and agropastoral areas of four eastern African countries: Ethiopia, Kenya, Tanzania and Uganda.

Jean Ndikumana
A-AARNET Co-ordinator

Acknowledgements

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USAID/OFDA provided the funding under the framework of the support to the Crisis Mitigation in Livestock Systems Project. We are indebted to Dr Raymond Meyer, Dr Carole Levin and their colleagues for their invaluable support and encouragement throughout the study.

The TAMU team, led by Prof Jerry Stuth, was involved in designing the questionnaire (Prof Jerry Stuth and Dr Peggy Hamlett), the survey design through the spatial delimitation of the survey zones (Dr John Corbett, Prof Jerry Stuth and Dr Abdi Jama) and contributed significantly to data analysis and report write up (Dr Peggy Hamlett, Prof Jerry Stuth and Dr Abdi Jama). Our joint efforts made this study successful.

The study was carried out with the invaluable administrative support of the Inter- national Livestock Research Institute (ILRI), particularly the office of the Chief Financial Officer. We are thankful to the ILRI management and particularly to Dr Hank Fitzhugh (ILRI Director General) and to Dr Michael Smalley (Director of Strengthening Partnerships for Livestock Research, SPLR) for their unflinching support and encouragement. Contributions and advice from Mr Ralph von Kauffman, Prof Sahr Lebbie and Dr Azage Tegegne were particularly appreciated.

Dr Sarah Ossiya was highly instrumental in the write up of the advanced draft of this report. Her contribution is greatly appreciated. A-AARNET staff members including Roger Kamidi (Data Analyst), Dr Raphael Marambii (Information Officer) and Gladys Mungai (Administrative Assistant) were also highly instrumental in data analysis, report write up and typing. Without their contribution, this report could not have been published. Technical assistance and useful comments from Dr John McPeak and Dr Peter de Leeuw are acknowledged with appreciation.

This study was implemented under the supervision of a number of colleagues from the national agricultural research systems (NARS) in the countries where the investigation was done. They are Ngoavu Mnene and Dr Faustin Wandera of the Kenya Agricultural Research Institute (KARI) in southern Kenya; Dr Robert Shavulimo and Peter Kamau of Egerton University, and Mike Wekesa and Geoffrey Leparteleg of the Drought Preparedness, Intervention and Recovery Programme (DPIRP) in northern Kenya; Dr Zinash Sileshi and Ebule Ebro of Ethiopian Agricultural Research Organization (EARO) in southern Ethiopia; Margareth Kingamkono, Stella Bitende and Dr Rhodes N. Mero of the Department of Research and Development in northern Tanzania; Angelo Mwilawa and Dr D.S. Sendalo of the Department of Research and Development in central Tanzania; Suleiman Kaganda and the late Efrem Wella of the Department of Research and Development in north-western Tanzania and Dr Cyprian Ebong and G.S. Byenkya of National Agricultural Research Organisation (NARO) and Dr Felix Bareeba of Makerere University in central/south-western Uganda. The above colleagues worked in close collaboration with regional and district agricultural and livestock development officers at their respective sites. The study could never have been done without the commitment and participation of all these colleagues.

Finally, we are grateful to all enumerators and pastoralists who made this study a successful joint venture between scientists, extension workers and pastoralists.

Executive summary

A survey of 663 households investigating coping mechanisms of pure pastoralists and agropastoralists, during the 1995–97 drought and 1997–98 El Niño rains (floods), was conducted in southern Ethiopia, northern and southern Kenya, northern, north-western and central Tanzania, and central/south-western Uganda. The study was co-ordinated by ASARECA (Association for Strengthening Agricultural Research in East and Central Africa) Animal Agriculture Research Network (A-AARNET) under the framework of the USAID/OFDA (United States Agency for International Development/Office of Foreign Disaster Assistance) funded Crisis Mitigation in Livestock Systems Project in collaboration with the International Livestock Research Institute (ILRI) and the Global Livestock Collaborative Research Support Program (GL-CRSP) Livestock Early Warning Systems (LEWS) co-ordinated by Texas A&M University (TAMU). The GL-CRSP LEWS and the Crisis Mitigation in Livestock Systems teams in eastern Africa conducted the survey under the supervision of Dr Jean Ndikumana, the A-AARNET co-ordinator. TAMU and the Crisis Mitigation in Livestock Systems co-ordination office provided technical expertise in designing the survey and assistance in data analysis and write up of the report. The survey forms the foundation for selection of households in order to monitor the livestock situation throughout the year in the framework of the implementation of the LEWS and Crisis Mitigation in Livestock Systems Projects.

The purpose of the study was to provide baseline information about what pastoralists do to sustain themselves and their livestock during the crisis periods of drought and flood. The survey focused mainly on assessment of the effects of the climatic crises on livestock dynamics and household welfare, the coping mechanisms adopted by pastoralists to mitigate the effects of these crises and the efficacy of the coping mechanisms adopted. It also provided insight into the type of assistance which was given to the pastoralists to mitigate the drought and/or flood effects and the pastoralists' perceptions as to how timely and efficient that assistance was.

Based on analysis of the cold cloud duration (CCD) and on the normalised difference vegetation index (NDVI), the investigated period was divided into five phases: (i) pre-drought (1 January to 10 May 1995); (ii) peak drought (11 May 1995 to 31 March 1997); (iii) minor rains (1 April to 31 October 1997); (iv) El Niño rains (1 November 1997 to 31 May 1998); and (v) La Niña dry (1 June to 31 December 1998).

The 1995–97 drought as well as the 1997–98 El Niño rains had significant adverse effects on the livestock populations at all the investigated sites. During the drought, cattle mortality rates were highest in southern Ethiopia and northern Kenya where they increased to 49% and 35%, respectively. Small ruminant drought mortality rates were also highest in southern Ethiopia and northern Kenya, increasing to 52% and 43%, respectively. The lowest drought mortality rates for cattle were observed in southern Kenya agropastoral areas, north-western Tanzania and central/south-western Uganda (13%, 15% and 17%, respectively). For small ruminants, drought mortality rates were lowest in southern Kenya agro- and pure pastoral areas and in central/south-western Uganda (11%, 21% and 22%, respectively).

The detrimental effects of floods included increased incidences of parasitic and epidemic diseases among humans and livestock (particularly small ruminants) and the destruction of infrastructures. Cattle mortality during the floods was highest in southern Ethiopia (37%) while small ruminant mortality was highest in northern Kenya (52%). Flood mortality was attributed mainly to diseases. The El Niño rains did not adversely affect all respondents. In certain areas

(e.g. parts of southern Kenya and north- western Tanzania) the rains were reportedly beneficial for forage and crop production.

Although migration was observed throughout the year, it increased during the drought, as the search for water and forage intensified. For example, in southern Ethiopia during the drought, pastoralists had to trek their animals 54 km for grazing and 77 km for water as compared with 15 and 22 km, respectively, prior to the drought.

During the crisis periods in the agropastoral zones of central/southwestern Uganda, and northern and central Tanzania, livestock grazing was commonly supplemented with crop residues. However, very little supplementation, mostly in the form of shrub/tree fodder, was available in the driest pure pastoral areas of northern Kenya and southern Ethiopia. The overall percentage of pastoralists supplementing their animals was generally low, averaging less than 10% of the livestock owners.

Disease incidences increased during both drought and El Niño rains. At all sites, more than 60% of respondents reported increased incidences of infectious and parasitic diseases of cattle during the drought period. Increased disease incidence for small ruminants was reported by more than 40% of the respondents. During floods in northern Kenya, there was an outbreak of contagious caprine pleuro-pneumonia (CCPP) that caused great losses in the small ruminant population. There were also incidences of Rift Valley fever that affected cattle and human populations during the El Niño rains.

Cattle sales and slaughters were not significantly different across climatic periods. The overall average cattle sales were below 10% and slaughters were below 2%, prior to and during crises periods. Small ruminants sales were also below 10% but slaughter rates, at 3%, were slightly higher than those for cattle. It appears, therefore, that pastoralists did not increase sales of livestock either prior to, or during the crises periods, despite the high mortality rates. This suggests that few pastoralists prepare for drought and/or flood by increasing sales or slaughter of their animals.

During the drought period, most of the normal water sources dried up and people suffered from a lack of clean water for household consumption. Decreased availability of milk and milk products led to increased consumption of cereals and grains. During the El Niño rains, pastoralists were also affected by increased incidences of parasitic diseases such as malaria, and outbreaks of cholera and Rift Valley fever.

In northern Kenya, 50% to 80% of respondents acknowledged that they received relief food. However, at all other sites, the responses of governments and other organisations were considered by the beneficiaries to be ‘too little, too late’. In southern Ethiopia for example, where the crises were worse than in northern Kenya, as few as 30% of the pastoralists received relief food during the most critical period. Sharing of received food aid with relatives and neighbours increased during drought at all sites. In northern Kenya, northern Tanzania and southern Ethiopia, more than 50% of pastoralists reported that they shared relief food during drought.

Several overarching factors determined pastoralists’ coping behaviours during the 1995–97 drought and the 1997–98 El Niño rains. Water and grazing for livestock, and food and clean water supply for human consumption were the primary factors. Other factors included household and herder illnesses, livestock diseases, local, national and regional communication infrastructure, and tribal conflicts. A general overall implication was ‘that which affects livestock, affects pastoralists’.

It is concluded, that an early warning system, which could efficiently (i.e. in a timely and accurate manner) inform or warn the pastoralists coupled with innovative conflict resolution techniques alongside traditional interventions could significantly reduce the negative effects of adverse climatic changes on pastoral communities. Moreover, other recent developments of statistical and dynamic weather forecast models, which can be used to forecast emerging La Niña and El Niño episodes several months in advance, should be considered for their potential to compliment and add value to present mitigation aids.

1 Background to the study

1.1 Introduction and significance of the study

Human conflicts and natural disasters, such as drought, floods and epidemics, have stifled development opportunities within the Greater Horn of Africa (GHA). Disasters threaten food security through disruption of normal cropping, pastoral and marketing activities with negative impacts on economic growth. When they occur, development resources are diverted to relief activities. To address these issues and other common problems, the seven country members of the Inter-Governmental Authority on Drought and Development (IGADD) have adopted food security along with communications and conflict resolution, as the three highest priority areas of intervention. The national agricultural research systems (NARS) in these countries have formed the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) to foster a regional approach and provide a vehicle for collaborative research activities including investigations of livestock systems. For the livestock sector to fulfil its important economic and food security role, mechanisms must be put in place to strengthen the coping strategies by which the sector withstands the vagaries of drought, human conflict and disease epidemics, as well as other disasters.

Livestock in the GHA are a vital resource in promoting development. Nationally, they provide 20% to 30% of gross domestic product and, at the farmer level, as much as 70% of cash income is generated from livestock. In arid and semi-arid areas, which account for more than 70% of the total land area of the GHA, livestock have the ability to withstand severe fluctuations in weather patterns and environmental shifts and, therefore, provide both food and income security. Hence the heavy involvement of the people of this region in animal agriculture.

Drought and political insecurity are the most damaging crises affecting pastoralists in the GHA. These catastrophic events have long-term impacts on pastoralists through decreased food security and lost purchasing power. In some cases livestock enterprises cannot regenerate themselves. Somalia and Rwanda provide tragic examples of how devastating drought and/or political insecurity can be. As a result of recent events in Somalia, the sizes of national cattle and goat herds have decreased by 70% and 60%, respectively. In such situations, some people will be able to recover over several years but many people who lost their entire herds will lack the capacity to rebuild their livestock resource. In Rwanda during the 1994 civil war, livestock numbers were decimated by nearly 90%. This caused great distress to the population but evoked very little response from the government and from the international community, partly because there was no experience or any pre-tested plans to draw on.

During severe droughts, such as those that have occurred in the GHA during almost every decade of this century, distress sales of livestock cause livestock prices to decrease, often precipitously, relative to the cost of staple grains. Later, when pastoralists are seeking to restock their herds, livestock prices increase rapidly. The low revenue from sales of livestock during the drought period does not cover the cost of restocking during the recovery period, especially since some revenue will have been used in the meantime to purchase expensive staple food grains. Furthermore, inappropriate policies tend to promote the adoption of inappropriate short-term practices, such as the cultivation of fragile dry lands which leads to environmental degradation with long-term consequences. These factors make it increasingly difficult for pastoralist and other societies to recover between disasters, thus making them more dependent on relief. As pointed out by Mutea and Lelei (1994), unlucky pastoralists, who incur heavy livestock losses or those who were living ‘marginal existences’ before the onset of the drought, end up settling as destitutes at trading centres.

Pastoral people have developed a range of responses to crisis situations that accommodate socio-economic and ecological concerns. However, these have become increasingly ineffective because of growing populations and encroachment of cultivators and others on traditional grazing land, particularly the best dry season grazing land which is also the best land for cropping. The ineffectiveness of present remedies is evident from the increasing scale of human suffering when drought or other types of crisis occur. Thus, new responses need to be developed which reinforce the traditional systems so that they can be adopted with minimal social disruption.

Global development experience indicates that livestock should play a more important role in GHA economies as human populations increase and economies grow. Animal agriculture will do this not only in the context of rural development but also through the opportunities the sector generates for urban employment. For the GHA livestock sector to fulfil its natural economic and food security role, mechanisms must be put in place to strengthen the coping mechanisms by which the sector withstands the vagaries of drought, political insecurity or other disasters. Implementing the concept of the ‘relief to development continuum’ is critical to helping this sector grow and con- tribute to human well-being.

There have been six drought episodes on the African continent in the last four decades: 1965–66, 1972–74, 1981–84, 1986–87, 1991–92 and 1994–95 (IPCC 1998). The 1981–84 drought was the worst ever recorded for the GHA countries, while the 1991–92 drought was the worst reported this century for the Southern Africa Development Community (SADC) countries (IPCC 1998).

Severe drought conditions affecting the GHA region are associated with the El Niño southern oscillation (ENSO) phenomenon. The term ENSO describes the coupled ocean atmosphere climate system which includes both El Niño and La Niña events. El Niño episodes are preceded by a build-up of warmer than usual sea surface temperatures (SSTs) in the equatorial Pacific. Cooler than normal sea surface conditions characterise La Niña episodes. Both types of episodes are strongly evidenced in normalised difference vegetation index (NDVI) records (Anyamba and Eastman 1996). Both El Niño and La Niña SST anomalies affect global climate patterns. Recent studies show some association between ENSO and drier than normal or unusually high rainfall conditions in eastern Africa (Atheru 1999). For the northern sector of eastern Africa (GHA sub- region), peak rainfall is to a large extent concentrated between June and September. El Niño events are often, but not always, associated with above average rainfall over most parts of this sector. The southern sector of the region has peak rainfall concentrated mainly in the months of December to February (Atheru 1999). Seasonal rainfall characteristics for the equatorial sector are, however, more complex. Recent diagnostic studies revealed a strong relationship between La Niña events and below normal or poorly distributed rain for both seasons. Recent examples of this relationship include the March to May 1996 and October to December 1998 rainfall deficits over most of the sector (Atheru 1999). The 1994–95 drought and 1997–98 unusually heavy rains that affected the region may therefore be attributed to the La Niña and El Niño phenomena, respectively. This study focused on the period from 1 January 1995 to 31 December 1998. The El Niño rains of 1997–98 were followed by La Niña dry conditions which overlapped into 1999 causing two consecutive failed rainy seasons with prediction that dry conditions would continue for the rest of 1999 in pastoral areas of Ethiopia and Kenya.

The challenge of drought calls for strategies, skills and tools in the following three areas: (i) monitoring/tracking and forecasting (early warning), i.e. the ability to track environmental changes using reliable indicators; (ii) mitigation, i.e. coping mechanisms which can be instituted in a timely manner to meet the environmental challenges; and (iii) resilience and recovery, i.e. an ability to rebound from catastrophic events, so that long-term destitution does not immediately follow short-term losses, destroying pastoral economies (Niamir-Fuller 1998).

Indicators of environmental changes must be of ecological and biological significance as well as being interpretable by the users and thus transferable into meaningful decisions and actions (Dyson-Hudson 1991; Niamir-Fuller 1998).

Tracking the rangeland environment in a predictive manner (early warning) is the first key step towards effective mitigation and intervention. However, Dyson-Hudson (1991) noted that while pastoralists in eastern Africa demonstrated an ability to describe their environment and indeed to recognise drought, they were unable to utilise that information in a predictive manner. Scientists have been equally inept at tracking the rangeland environment in a predictive manner (Dyson-Hudson 1991). Early warning systems (EWS) instituted by national governments have focused on crop production and thus utilise indicators which are geared towards crop production, and therefore to generally less drought prone areas.

Institution of a reliable livestock early warning system (LEWS) therefore requires: (i) reliable indicators which are focused on the needs of pastoralists and can be translated into appropriate and timely action; (ii) coping mechanisms which are effective, enabling rapid response to indicator advisories and making provision for recovery; and (iii) a well established and co-ordinated disaster management network at the local, regional, national and even international levels (since pastoralists do not necessarily respect inter- national borders) in order to effectively communicate the warning, and facilitate coping mechanisms and the recovery process.

Niamir-Fuller (1998) identified various indicators which pastoralists use to track their environment, including faecal quality. From these indicators, pastoralists are able to understand current environmental phenomena; however, interpretation is subjective and there is apparently very little ability to translate the knowledge gained into an early warning signal. Currently employed scientific methods have limitations for use in the rangelands of sub-Saharan Africa (SSA) (Ossiya 1999). Near infrared reflectance spectroscopy (NIRS) faecal profiling is a recent innovation (Lyons and Stuth 1992; Leite and Stuth 1995; Showers 1998; Coates 1999; Ossiya 1999) in which NIRS is used to scan faecal samples in order to predict the diet of free-ranging livestock. This tool provides an objective and reliable indicator with an early warning capability when interfaced with a geographic information system. NIRS faecal profiling has potential for compatibility with pastoral communities since the indicator (livestock faeces) is one for which an indigenous knowledge system is already in existence (Niamir-Fuller 1998; Ossiya 1999).

Nevertheless, Niamir-Fuller (1998) noted that ‘although [early warning] knowledge is extremely important, the focus must be on the mechanism by which such knowledge is translated into actions, rules and changes [coping mechanisms] to the [pastoral] system’.

There is a link between the indicator (focus of monitoring) and the response elicited (the coping mechanism). An appropriate indicator that is translatable into timely action ensures protection (through appropriate mitigation) and promotion (capability to rebound from the catastrophe) of the pastoral economy. Retrospectively, most EWS have elicited a response in terms of provision of food entitlement (food aid), which in fact signals that the monitoring indicator and/or its translation into action were inappropriate.

A starting point in designing a LEWS is to focus on how pastoralists pursue their livelihoods rather than on how they fail to do so. Dyson-Hudson (1991) and Niamir- Fuller (1998) noted that pastoralists employ both tools and skills that are translated into specific socio-economic structures in managing livestock production off the rangelands. Swinton (1988) and Dyson-Hudson (1991) noted that in drought prone regions strategising for drought is central to economic planning. The coping mechanisms employed by pastoralists are therefore incorporated into the fabric of their livelihoods, and are brought into play and/or intensified with progression of environmental stress. Coping mechanisms implemented by pastoralists therefore provide insight into how pastoralists perceive and pursue their livelihoods (issues of risk aversion and tolerance) in a highly heterogeneous and precarious environment. Moreover, knowledge of the coping mechanisms used will thus provide insight into what indicators are needed, their appropriateness, and when and how the indicator signals should be translated into action that supports the pastoral economy.

The purpose of this study was, primarily, to document the impacts of the climatically stressful episodes, the 1995–97 drought and the 1997–98 El Niño rains, on the environment, livestock herd dynamics, and livestock and human welfare in the pastoral areas of the GHA. The responses of pastoralists and their livestock and the type and efficacy of coping mechanisms employed were investigated. In many situations, the temporal and spatial reaches of climatic stress stretch and overwhelm the coping capacity of pastoral communities and external assistance has to be sought. Therefore, external assistance given to the pastoralists and the pastoralists' perceptions of how appropriate this assistance was were also examined.

The secondary objective of this study was to provide insight into the way that pastoralists pursue their livelihoods, so that in future, appropriate EWS can be instituted to mitigate the adverse effects of crisis situations.

Drought management strategies are an integral part of livestock production in the precarious rangelands of SSA. Campbell (1984) and Behnke and Kerven (1995) noted that it is a traditional strategy of pastoralists to build up livestock numbers in favourable years in anticipation of recurrent drought (or incidental flooding). Pastoralists thus attempt to ensure that enough animals survive the ravages of the climatically stressful period in order to form a breeding population, thus ensuring resilience (Behnke and Kerven 1995). However, Cossins (1985) noted that when droughts end, there is no immediate relief. It may take at least five years for the system to recover to the level of confident subsistence, unless another climatically stressful period occurs, in which case recovery takes longer (Cossins 1985).

Campbell (1984) noted that while the immediate impact of stressful environmental periods may be devastating, the periods prior to, in between, and after these episodes are equally important in determining the livelihood of pastoral peoples. For example, the condition of the livestock herds (health and numbers) before the stress period, influences their capacity to survive. Pre-stress, in-between and post-stress periods are important determinants of whether pastoral populations recover, or long-term (even lifetime) destitution sets in. Mitigation and intervention can be instituted during pre- stress, stress and post-stress phases. The goal of LEWS is intervention before the onset of devastation due to the stress period, so that long-term destitution is avoided.

Pre-stress and post-stress periods are thus equally as important as stress periods in the planning of an EWS. Therefore, the temporal span of this study included periods before and after the climatically stressful periods of the 1995–97 drought and the 1997–98 El Niño rains. Events are documented, for the time period between 1995 and 1998, across five consecutive climatic phases: pre-drought, drought, minor rains (norm), El Niño rains and La Niña dry.

Other studies have been conducted to examine coping mechanisms of pastoralists both in eastern Africa and other parts of Africa, such as studies by Campbell (1984) and Cossins (1985). These studies have been mainly localised or restricted to a single pastoral or ethnic group. However, the impacts of pastoralists' decisions, especially in face of environmental stress, are felt beyond cultural and even international boundaries, calling for an integrated regional approach. Thus, the spatial span of this study was across four nations: Ethiopia, Kenya, Tanzania and Uganda.

Pastoralists are known to utilise different coping mechanisms in response to differing degrees of stress. In the GHA, there are different categories of pastoralists ranging from agropastoralists to pure pastoralists, with the degree of nomadism (lateral movement) generally increasing with aridity. During crisis situations such as severe drought, differences in the type and scope of coping mechanisms employed by these pastoralist groups reflect different perceptions of stress to the 'normal' environment (i.e. how much deviation from the norm is perceived), the stress tolerance of the group and the ability of the group to mitigate the stress. However, even though cultural differences exist, pastoral communities have often been found to employ similar coping strategies (Dahl and Hjort 1976; Campbell 1984). Moreover, Dahl and Hjort (1976) and Campbell (1984) noted that pastoral communities may employ some coping mechanisms similar to those of other communities. Pure pastoral and agropastoral areas in southern Ethiopia (S. Ethiopia), northern Kenya (N. Kenya), southern Kenya (S. Kenya), northern Tanzania (N. Tanzania), north-western Tanzania (NW Tanzania), central Tanzania (C. Tanzania) and central/south-western Uganda (C./SW Uganda) were included in this survey.

This report briefly discusses the methodology used in the study, the survey protocol and the climatic phases assessed. It also provides a brief description of the sampling zones as a background to the presentation of survey results. Data are presented which illustrate the impacts of the drought and excessive rainfall on natural resources pertaining to the livelihoods of pastoralists, livestock herd dynamics and human welfare. The pastoral coping mechanisms utilised and their efficacy are documented, as are the type and effectiveness of external assistance. The final section discusses the findings of the survey and their implications for early warning and mitigation, and submits recommendations towards the institution of effective LEWS for the nations of the GHA.

1.2 Methodology

1.2.1 Objective of the study

The general aim of this study was to obtain baseline information on the coping mechanisms of agro- and pure pastoralists during the climatically stressful periods of the 1995–97 drought and the 1997–98 El Niño rains through a household survey carried out in pure pastoral and agropastoral areas in S. Ethiopia, N. Kenya, S. Kenya, N. Tanzania, NW Tanzania, C. Tanzania and C./SW Uganda.

1.2.2 Climatic phases assessed in the survey

The four eastern African countries (Ethiopia, Kenya, Tanzania and Uganda) covered by the survey, experienced almost back-to-back climatically stressful periods between 1995 and 1998. Drought was followed by a short period of within the norm rainfall which in turn, was followed by heavy El Niño rains that caused flooding in some areas. These climatic periods, i.e. drought and heavy rainfall/floods, had consequences on the environment which impacted on food and feed security, health and welfare of the pastoral communities and their livestock, and therefore on the pastoral economies.

The phases assessed in the survey were identified in relation to climate especially rainfall on the basis of NDVI analysis. NDVI, reported at a resolution of 7 km, indexes the photosynthetic activity in vegetation, and therefore directly reflects the level of effective rainfall. NDVI data are more closely related to livestock production than rainfall since NDVI is a measure of forage productivity, including both presence and vigour of forage (USAID 1999). In contrast, use of rainfall as a measure of livestock production is confounded by the time lag between reception of rain and forage response. Furthermore, factors such as high evaporation and runoff can render rain received less effective than is intimated from direct measurements of rainfall.

NDVI data for each zone were obtained and grouped in dekads over the period 1995–98; a total of 144 dekads was obtained. These NDVI data were then plotted against the long-term average to illustrate the deviation from the average (Figure 1).

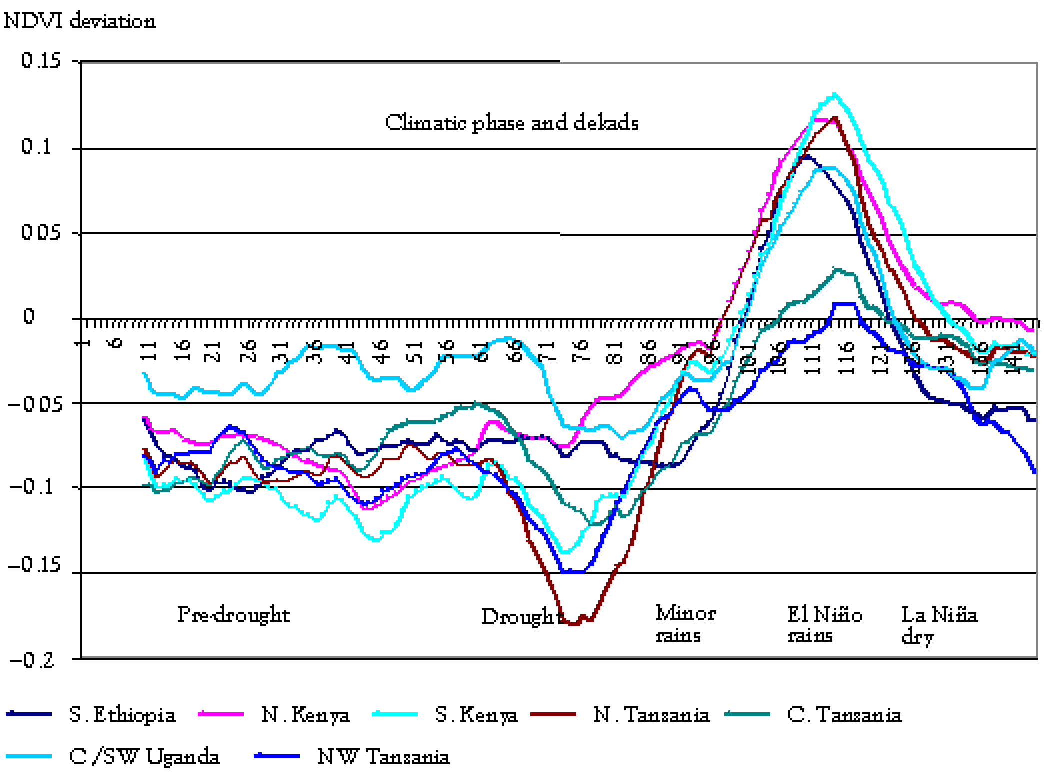


Figure 1. *The three-month NDVI running average for the different zones depicting the NDVI deviation from the long-term average of the climatic phases surveyed.*

The first year (1995) is represented by dekads 1–36, 1996 by dekads 37–72, 1997 by dekads 73–108 and 1998 by dekads 109–144. The rainfall patterns in the zones are slightly to strongly bimodal, i.e. zones receive both short and long rains. In each year, the long rains are generally expected to fall between March and May (from the 7th to 15th dekad) and the short rains to fall between October and December (from the 28th to 36th dekad). Rainfall patterns varied between the zones, as is evident from Figure 1, however, there was a common trend across zones which was used to delimit the climatic phases.

In 1995, the long rains (expected dekad 7–15) failed, with all zones except C./SW Uganda receiving between 5% and 10% less than average. The 1995 short rains (expected dekad 28–36) also failed. This was followed by a failure of the long rains in 1996 (expected dekad 43–51). There was a severe failure (NDVI data over 10% below average in S. Kenya, N. Tanzania and NW Tanzania) of the short rains in 1996 (expected dekad 64–72). These data show that four consecutive rainy seasons failed (two short and two long); this period delimited the drought[1] phase, and spanned 23 months.

1. This definition of drought is borrowed from Coppock (1994) who described drought as a period when two or more consecutive dry years occur in which the length of the growing period is less than 75% of the mean, i.e. a drought is driven by several consecutive rainy seasons in which deficient rainfall [has] detrimental effects on the production system.

Corbett (1988) recognised three stages of drought, with increasing severity and thus eliciting a hierarchy of response. Corbett (1988) therefore intimated drought as a progressive phenomenon rather than a singular occurrence. Coppock (1994) noted that designation of drought as a one-year event was inconsistent with other findings in which drought was observed as a multi-year phenomenon. Dyke (1999) described a crisis situation warranting an alert signal (drought?) as one in which NDVI data were –20% from the norm. However, the current survey indicated that marked detrimental effects occurred before NDVI data reached –20%.

Figure 2 presents the cumulative NDVI data for the different zones, which confirm that the prolonged drought was due to the ineffectiveness of rainfall received in the four consecutive rainy seasons. The long rains of 1997 arrived as expected (between dekad 79 and 87) and tended towards the norm; thus, this period delimited the minor rains phase. These rains were followed by heavier than expected rains that fell between October 1997 and May 1998 (dekad 102–126); this period delimited the El Niño phase.

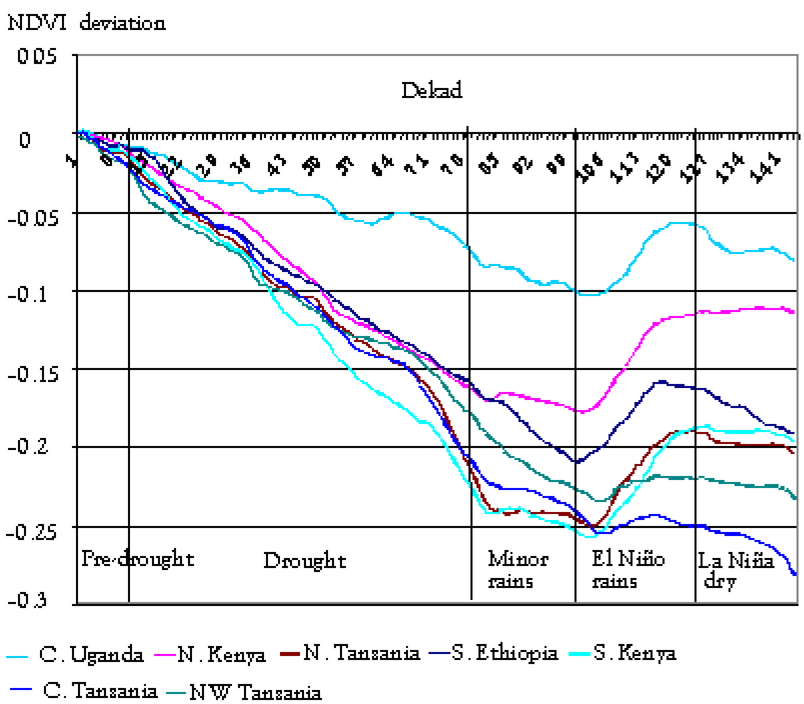


Figure 2. *The cumulative NDVI data illustrating the prolonged drought due to the cumulative effect of four failed rain seasons: two short and two long.*

NDVI data for the period June to December 1998 (dekad 127–144) showed that the weather pattern went from the previous very wet period into a dry period; this period delimited the La Niña dry phase. Although there are slight variations between zones as to when each phase occurred, the above observations were used to delimit the phases as summarised in Table 1.

Table 1. *The climatic phases assessed in the survey: calendar delimitation, characteristics*

and implications of the phases.

Phase	Characteristics	Implications
Pre-drought 1 January 1995–10 May 1995. Dekad 1–12	Production phase	Pre-drought conditions determine ability to cope with drought. Early warning would reduce losses during climatically stressful period
Drought 11 May 1995–31 March 1997. Dekad 13–81	Coping and survival phase. The last major drought occurred in 1986–87	Stressful period: a focus on ensuring survival of breeding stock
Minor rains 1 April 1997–31 October 1997. Dekad 82–102	Recovery and restocking phase	Opportunity to recover from drought. Period too brief to allow recovery process
El Niño rains 1 November 1997–31 May 1998. Dekad 103–126	Coping and survival phase: record breaking floods in some areas, comparable only to those that occurred in 1961–62. El Niño rains were not detrimental in all areas	Followed in quick succession to drought adding to the challenge of recovering from both the drought and El Niño rains
La Niña dry 1 June 1998–31 December 1998. Dekad 127–144	Recovery and restocking phase	Stipulated as a recovery and restocking period but identified as being drier than the norm; therefore, could compromise the recovery process

Effects of the climatic stresses on the pastoral communities may have been exacerbated greatly by the short recovery period (minor rains) between the two periods of stress. The two different types of climatic stress (drought followed by unusually heavy rainfall) increased the challenge faced by the pastoral communities. NDVI data showed that the La Niña dry conditions overlapped into 1999 causing another failed long rainy season. This was coupled with a prediction that dry conditions would continue for the rest of 1999. This prediction has since been confirmed as dry conditions have continued throughout 1999; this weather pattern has dire implications for the recovery of the pastoral economies.

The survey was structured to analyse the environmental impacts of each climatic phase, as well as the effects on human and livestock welfare; moreover, the survey examined pastoralist coping mechanisms and their efficacy, during each climatic phase.

1.2.3 Study implementation and protocol

The study was conducted as a joint effort between the ASARECA-Animal Agriculture Research Network (A-AARNET) and the Global Livestock-Collaborative Research Support Program (GL-CRSP) LEWS teams. It was initiated and co-ordinated by the A-AARNET Co-ordinator in collaboration with the International Livestock Research Institute (ILRI). The GL-CRSP LEWS team at Texas A&M University (TAMU) provided technical expertise in designing the survey, and assistance in data analysis and the write up of the report. The LEWS and Crisis Mitigation in Livestock Systems Project teams operating in Ethiopia, Kenya, Tanzania and Uganda, co-ordinated the implementation of the study on the ground. A complete list of participants is provided in Appendix II.

The primary goals of the study were to identify the impacts of the climatically stressful episodes on the environment, and human and livestock welfare, and to identify the coping mechanisms employed and their efficacy so that appropriate interventions could be identified. However, a secondary goal was to identify households in order to establish a monitoring system for the implementation of the GL-CRSP LEWS and Crisis Mitigation in Livestock Systems Project. Data obtained from the households will be used in livestock decision support models to predict crisis situations (due to forage deficiencies) six to eight weeks before they can be deduced from body condition assessment. As noted by Lyons (1990), body condition is a reflection of past nutrition and thus precludes timely intervention.

Spatial delimitation of survey zones

In consideration of the importance of livestock in the livelihoods of the communities in the area, seven zones were selected for the study. They were southern Ethiopia (S. Ethiopia), northern Kenya (N. Kenya), southern Kenya (S. Kenya), northern Tanzania (N. Tanzania), north-western Tanzania (NW Tanzania), central Tanzania (C. Tanzania) and central/south-western Uganda (C./SW Uganda). For each zone, a maximum sampling range was defined using the Almanac Characterisation Tool. This involved the use of cluster analysis to create effective environments from which areas of similar climate associated with pastoral ecologies were derived (Corbett et al. 1998). The sampling range was then stratified into pastoral ecoclimates, i.e. arid, semi-arid, grassland savannah and woodland savannah (Figure 3). Cattle densities (Figure 4) were overlaid on the pastoral ecoclimates, as were human population densities (Figure 5; areas of high human population densities such as cities and towns were excluded). Area covered by each unique combination of layers was determined and designated as a climatic cluster (Figure 6). Households were selected on a proportional basis, i.e. according to the proportion of the zone covered by each unique climatic cluster. The sampling zone was then overlaid on a road grid and global positioning system (GPS) units (latitude and longitude points) were used to locate each household. A map showing climatic clusters and the distribution of households selected for survey in the N. Tanzania zone is presented in Figure 7. The complete set of maps showing climatic clusters and the distribution of selected households for each zone surveyed is given in Appendix III.

Pastoral ecoclimatic zones of eastern Africa: N. Tanzania

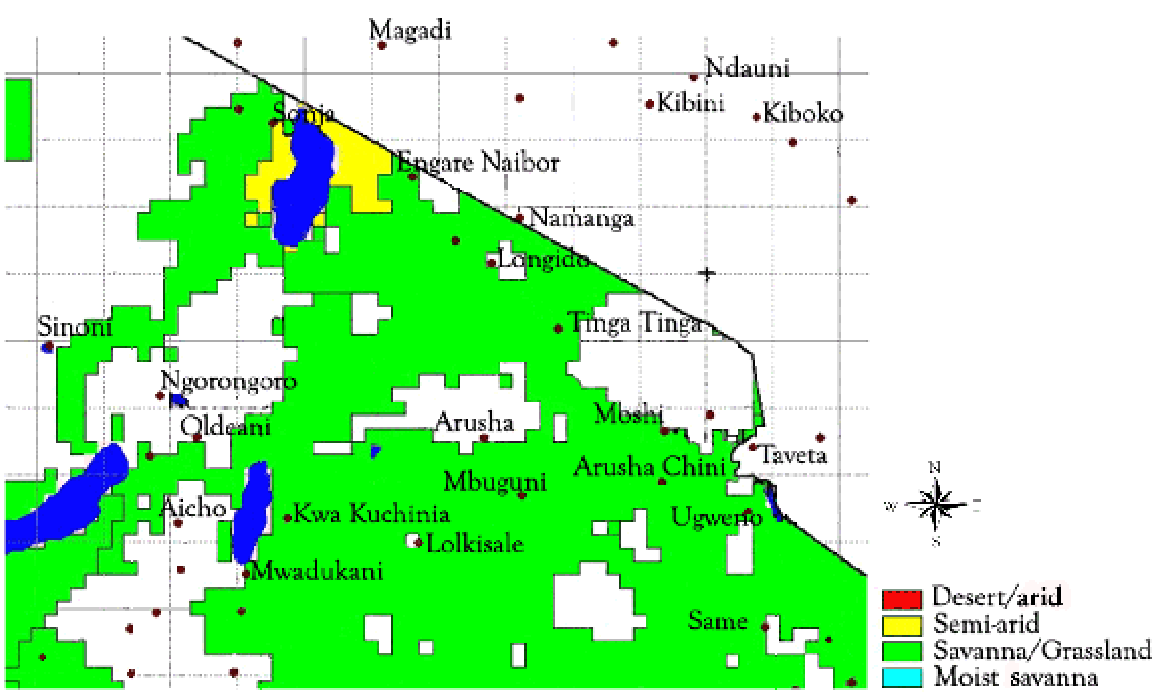


Figure 3. *An example of the pastoral ecoclimatic zone maps used in the overlays to delimit*

zones surveyed.

Cattle density of eastern Africa: N. Tanzania

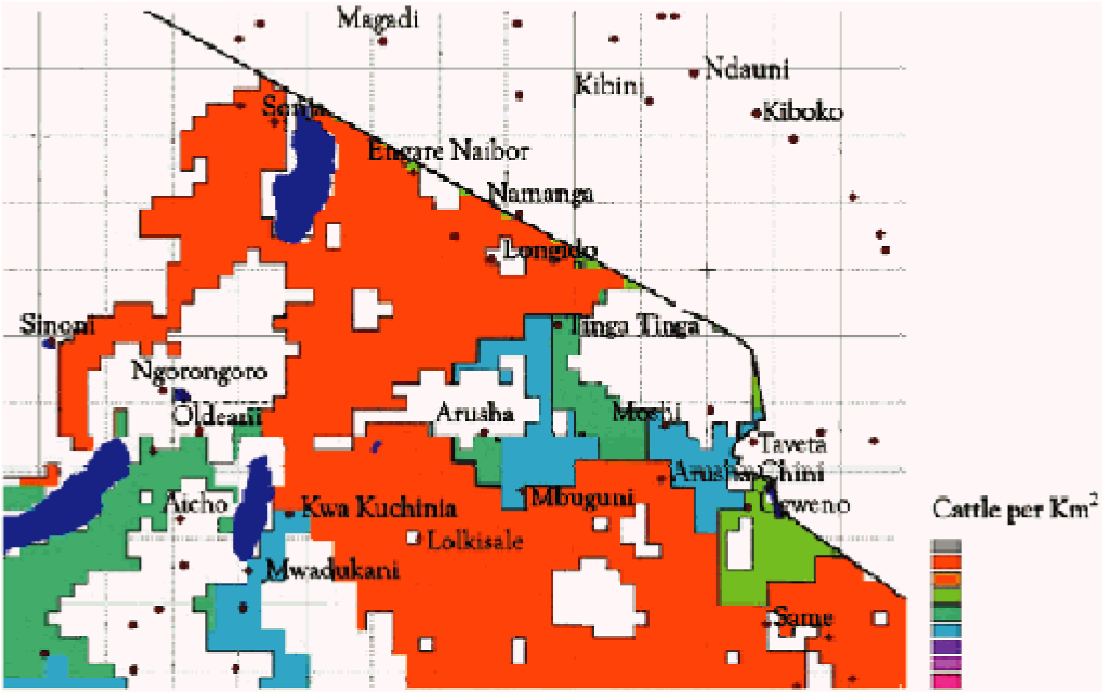


Figure 4. *An example of the cattle density overlay maps used to delimit the survey area.*

Human population density: N. Tanzania

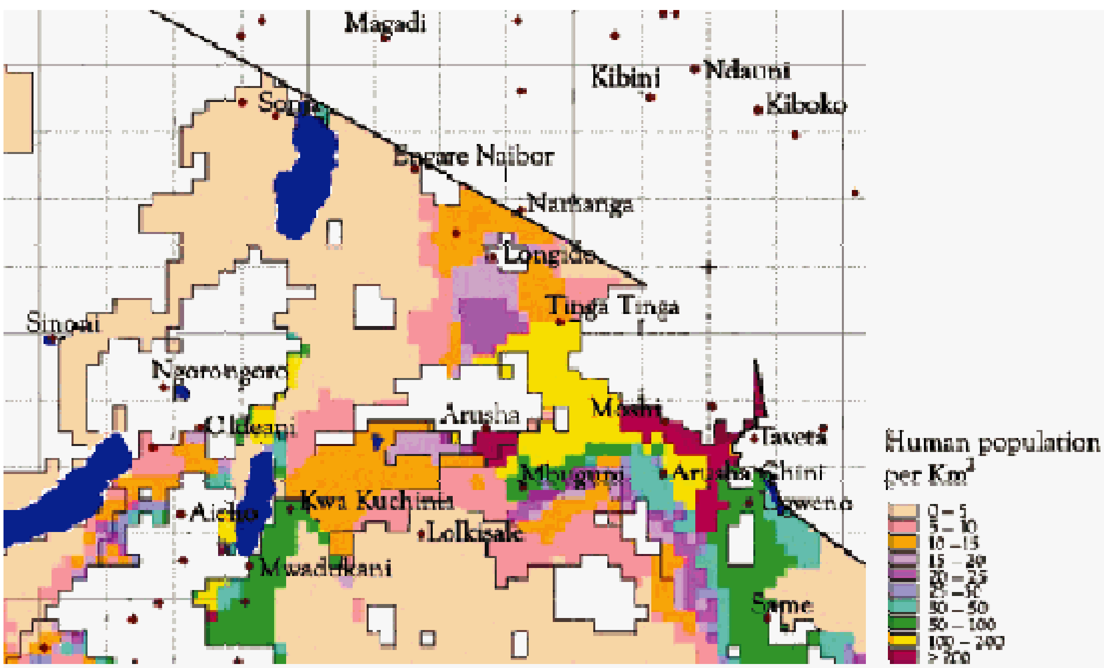


Figure 5. *An example of the human population density overlay maps used to delimit the survey area.*

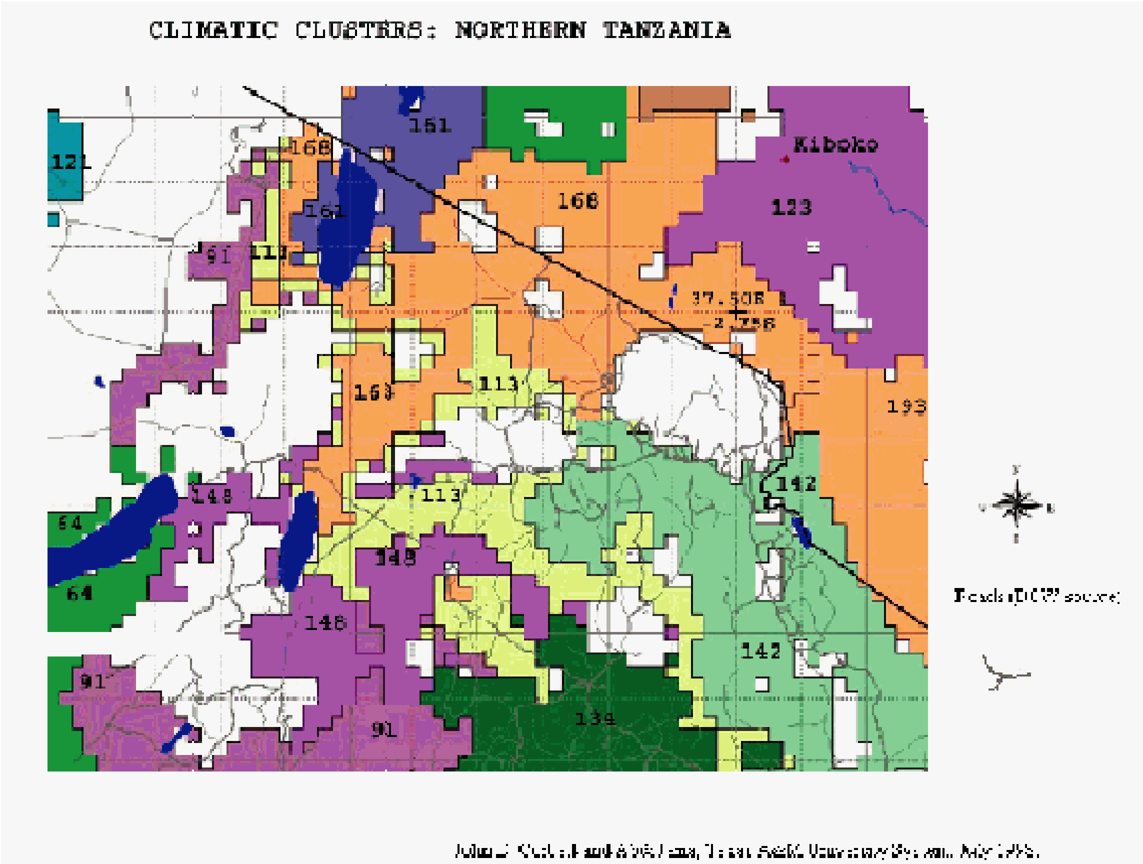


Figure 6. *An example of the climatic clusters maps produced by overlaying pastoral ecoclimatic zones cattle density and human population density data*.

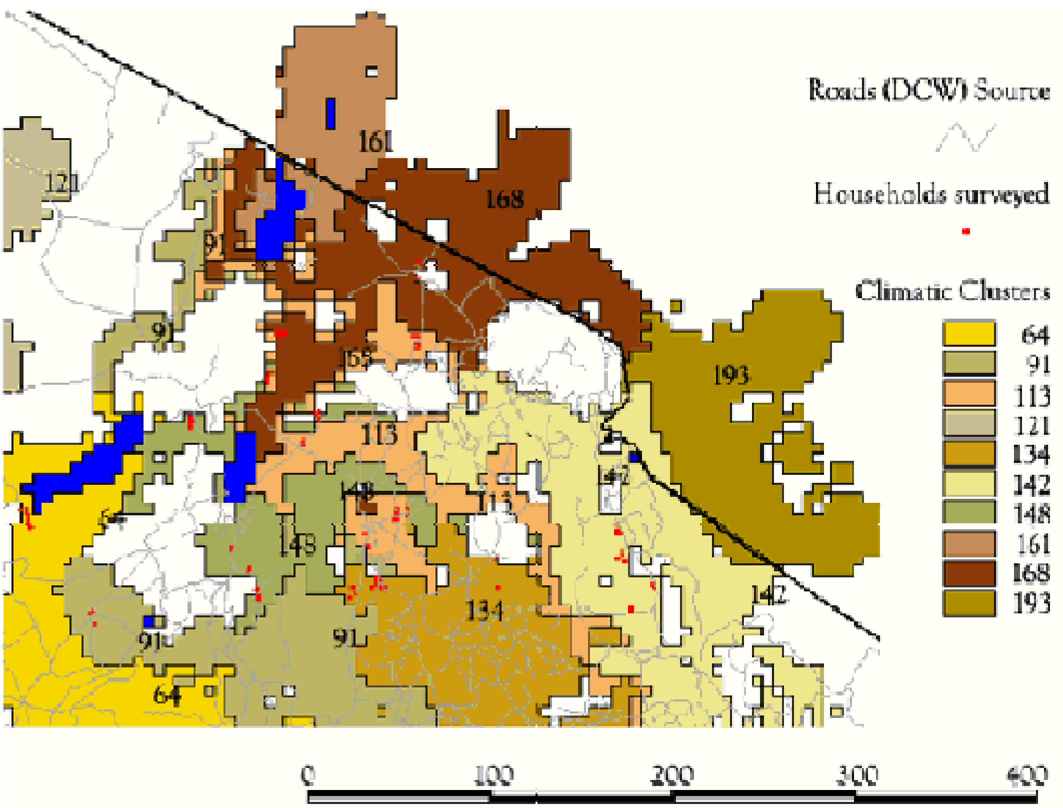


Figure 7. *An example of the distribution of the households surveyed per cluster.*

Monitors and enumerators

Monitors and enumerators (20–40 years old) were selected to assist in carrying out the survey. A number of them had some degree of formal training in range science and/or animal health. Some of the monitors and enumerators had previous experience in collecting survey data. In N. Kenya, the enumerators were individuals who were already involved in collecting survey data for the Kenya Drought Preparedness, Intervention and Recovery Programme (DPIRP), which had been in place for seven years.

Training sessions were conducted to acquaint monitors and enumerators with the goals of the survey and the household questionnaires. The instructional manual used was adapted from the World Bank Living Standard Measurement Survey Manual. Feed- back was solicited from the monitors and enumerators, to ascertain that questionnaires were appropriate and culturally sensitive, and translatable into local languages without loss of original meaning. Enumerators then carried out practice interviews in small groups prior to conducting the survey.

Survey protocol and questionnaire content

The sampled households in each zone were chosen randomly within clusters (Table 2) except in N. Kenya where some of the routine survey households established by DPIRP were used.

Table 2. *Identity (ID) of zonal clusters and the number of households per cluster for each of the zones surveyed.*

S. Ethiopia		N. Kenya		S. Kenya			
Cluster ID	No. of households	Cluster ID	No. of households	Cluster ID	No. of households		
21	17	41	27	123	15		
27	8	46	5	142	8		
35	14	57	23	161	14		
52	5	60	18	168	30		
58	17	90	4	184	1		
71	10	102	5	185	4		
74	1	104	8	189	25		
95	7	138	2	193	2		
112	1	139	1	194	1		
116	4	163	7	73	20		
211	1	–	–	–	–		
Total	85	Total	100	Total	120		
N. Tanzania		C. Tanzania		NW Tanzania		C./SW Uganda	
Cluster ID	No. of households	Cluster ID	No. of households	Cluster ID	No. of households	Cluster ID	No. of households
64	8	8	5	17	12	82	10
91	3	10	19	62	17	110	14
113	26	64	37	63	35	115	7
134	17	91	22	64	6	117	25
142	16	141	4	121	30	130	5
148	16	–	–	–	–	154	11
164	1	–	–	–	–	156	1
168	10	–	–	–	–	–	–

211	1	–	–	–	–	–	–
Total	98	Total	87	Total	100	Total	73

A household questionnaire (see Appendix I) that was designed with the household head as the respondent was used. Enumerators explained each of the five environmental phases to the respondents and questions were asked so as to cover each phase. A close interaction between researchers and pastoralists was important in order to win their confidence and obtain accurate information. A typical interaction scene captured in N. Tanzania is portrayed in Plate 1.

Plate 1. *A research team member talks with pastoralists.*

Research questions

The major issues raised by the questionnaire were:

1. What were the effects of, and responses to, the 1995–97 drought and 1997–98 El Niño rains as perceived by randomly selected pastoralists in each of the four eastern African nations. Effects were considered in relation to the local economy, environment/natural resources, socio-economic factors and pastoral welfare.
2. What are the effects/consequences (positive and negative) of the identified coping mechanisms?
3. What type of assistance was provided to the pastoralists to mitigate the drought and/or flood effects?
4. What are the pastoralists' perceptions of how well the assistance fitted the need?

A section on human demographics was also included to aid description of the socio-economic status of the pastoralists surveyed.

For the N. Tanzania zone extra questions, not part of the main questionnaire, were included to assess the effects of wildlife intrusion on pastoralists, their livestock and the environment.

1.2.4 Statistical analysis

The pastoral zones were stratified on the basis of climate, as well as livestock population; pockets of high human population densities were excluded. The number of households to be sampled was pre-assigned to each climatic cluster, proportionately on the basis of land area. Logistical problems (such as insecurity, inaccessibility and transport problems) resulted in under-sampling of some of the climatic strata. Consequently, it was not possible to make meaningful statistical comparisons among the pre-defined geographical clusters. Nevertheless, the statistical results obtained were, to a large extent, pertinent to whole pastoral zones. Results were also analysed so as to compare agro- and pure pastoral groups.

Summary statistics were obtained for livestock herd dynamics and distances to water and grazing sources over the various phases, from pre-drought to the La Niña dry period. Livestock dynamics data were subjected to analysis of variance and differences between means for different climatic phases were detected using the Least Significant Difference (LSD) values. Paired t-tests were used for comparisons between distances to emergency and primary sources of water and grazing.

Mortality rates and proportions of births, sales and slaughter were calculated for each livestock species during each climatic phase. Two mortality rates are reported: drought mortality was calculated as the number of deaths reported for peak drought and minor rains as a proportion of the pre-drought herd size; and flood mortality was calculated as the number of deaths reported for peak flood and the La Niña dry period as a pro- portion of the herd size during the minor rains phase. These calculations were based on the assumptions that net herd sizes over each climatic phase were reported and that animals which died during the minor rains and the La Niña phase died from the effects of drought and intensification of diseases attributed to the El Niño rains, respectively. Birth rates were calculated as the number of births expressed as a percentage of the number of cows, ewes, does or female camels in the herd during a given climatic phase. Purchase, sales and slaughter rates were the number of animals purchased, sold or slaughtered, respectively, expressed as a percentage of the whole herd during a given climatic phase.

Proportions were obtained for qualitative data on a variety of household welfare factors, food consumption patterns, types of household water sources, human illness, intra-community assistance levels, assistance received from various external sources and reasons for loaning animals. Proportions were also determined for qualitative data on a variety of factors which directly affected livestock, these included: types of livestock water sources; forage availability and sharing; herding labour trends; livestock diseases and treatments; and supplement feeding. Also covered were respondent demographics (religion, literacy and economic status), household profiles by age and gender, categories of household members left behind on relocation of herds, and reasons for leaving them behind.

1.2.5 Demographics of the pastoralists surveyed

The area demarcated as the S. Ethiopia zone is semi-arid to arid. The main pastoral group in this zone is the Borana people who are pure pastoralists. Somali clans are also found in this zone. The pastoralists in this zone are greatly dependent on livestock for food security.

The zone surveyed in N. Kenya is semi-arid to arid. The major pastoral groups are the Samburu, Turkana, Borana and Somali; these groups are either pure pastoralists or practise transhumance, i.e. the practice of moving between seasonal bases, while carrying out some cultivation at the wet season base (Niamir-Fuller 1998). The two major pastoral groups in the S. Kenya zone are the Maasai who are pure pastoralists and the Kamba who are agropastoralists.

The Maasai and Barbaig (pure pastoralists), and Iraqw and Pare (agropastoralists) peoples occupy the N. Tanzania zone. The Maasai, who are pure pastoralists, and the Gogo, Irangi and Nyiramba agropastoralists are found in the C. Tanzania zone. The Sukuma and Nyamwezi, who are agropastoralists, dominate the NW Tanzania zone.

The two zones in Uganda are combined as they have many similarities. The pastoral groups include the Bahima in SW Uganda, and the Banyankole and Baruli in C. Uganda. Agropastoralists, who raise crops, and semi-transhumant pastoralists who divide livestock into core and satellite herds constitute these groups.

The profile of respondents within the 664 households surveyed is presented in Table 3. The average number of persons per household was 14.5, with only N. Kenya, S. Ethiopia and S. Kenya showing fewer persons per household.

Table 3. *Average number of persons in household by age category for each zone.*

Zone	N[1]	Total in household	S.E[2]	Children	Youth	Male adults	Female adults	Elderly males	Elderly females
S. Ethiopia	85	13.5	0.5	6.3	2.5	1.4	1.4	0.8	1.1
N. Kenya	100	8.2	0.3	4.0	1.5	0.8	0.8	0.5	0.6
S. Kenya	120	14.4	0.5	6.7	2.5	1.8	2.6	0.3	0.4
N. Tanzania	98	18.1	0.8	8.3	3.3	2.1	2.9	0.6	0.9
C. Tanzania	87	18.3	0.7	7.0	3.9	2.7	3.3	0.5	0.9
NW Tanzania	100	14.6	0.5	7.3	2.5	1.6	2.1	0.4	0.7
C./SW Uganda	73	14.7	0.6	5.0	3.7	2.8	2.2	0.5	0.5
Mean		14.5		6.37	2.84	1.88	2.18	0.51	0.72

1. N = number of households.
2. S.E. = standard error.

On average, the children and youth constituted 64%, the elderly 9%, and working age adults only 28% of the households. These demographics would put great stress on the working adults in employment-based societies. However, children and adults in all zones participated in household chores and livestock herding. There was great pressure on women (who constituted 15% of the household) whose responsibilities included fetching water for human consumption and for livestock raised close to the households. The distance to water sources increased with the drought, and thus women had to travel long distances and/or create clean water sources (as in the case of Somali women who were observed digging side-holes next to rivers). Women had other household duties such as cooking, gathering and preparing cooking fuel (firewood and dung), caring for the elderly and sick, and caring for the small ruminants and breeding stock raised close to homesteads.

The religious, literacy and economic characteristics of the households were also surveyed (Table 4).

Table 4. *Profile (%) of respondents by age, religion, literacy and economic status.*

Category	S. Ethiopia	N. Kenya	S. Kenya	N. Tanzania	C. Tanzania	NW Tanzania	C./SW Uganda	Mean

Age group								
Twenties	8	3	8	6	2	4	11	6
Thirties	18	26	26	25	15	19	26	22
Forties	28	32	30	23	30	29	28	29
Fifties	20	24	19	20	14	24	24	21
Over fifty-nine	26	15	17	26	39	24	11	22
Religion								
Traditional	22	38	23	29	2	64	32	30
Christian	4	58	76	51	62	32	67	50
Muslim	74	3	1	17	23	1	0	17
No response	0	1	0	3	13	3	1	3
Formal education								
None	71	85	34	37	46	37	38	50
Literate	29	15	66	63	54	63	6	50
Economic status								
Higher than most	4	10	23	9	17	4	14	11
Same as most	73	42	68	70	78	93	71	71
Lower than most	23	38	9	21	5	3	11	16
No response	0	10	0	0	0	0	4	2

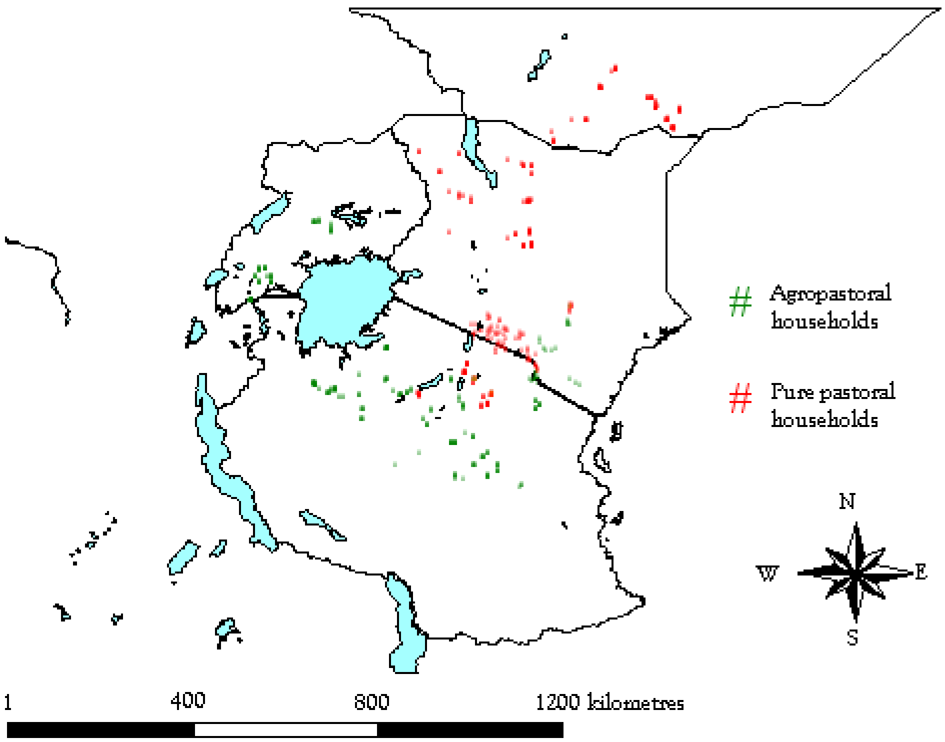
Of the 664 households surveyed, 50% were Christian. Most zones were dominated by Christian households; however, there was a predominance of Muslim households in S. Ethiopia, whilst most households in NW Tanzania embraced African traditional religions. It was evident that there were some inter-religious conflicts associated with resource use (especially access to water sources) in N. Kenya and possibly in other zones. These conflicts are likely to impact on intervention efforts and need to be addressed.

Across the zones, 50% of respondents (household heads) were literate. However, there were great differences in literacy rates between zones. Levels of literacy in S. Kenya, N. Tanzania, NW Tanzania and C./SW Uganda were above 60%, while in N. Kenya and S. Ethiopia levels were below the overall average, 15% and 29.4%, respectively. These findings have implications for intervention communication via written material and for documentation of pastoral indigenous knowledge systems. Respondents were asked to gauge the economic status of their household in comparison with the majority of the community. Most respondents (71%) perceived themselves to be of average economic status within their community. However, between 14% and 23% of the respondents in C./SW Uganda, C. Tanzania and S. Kenya stated that they had a higher economic status, whilst between 21% and 38% of the respondents in S. Ethiopia, N. Kenya and N. Tanzania claimed to have a lower economic status than the majority of households in their communities. The distribution of the poor (below aver- age economic status) was highest for N. Kenya and S. Ethiopia, the most arid zones. The poor are identified as one of the sectors of a community that are disadvantaged in economic development since they have little social influence and clout in the making of economic decisions. They are also the most drastically affected by climatically stressful episodes since they own fewer livestock and have less entitlement assets, such as rights to grazing lands. Their plight is not made any better by the fact that they are mostly found in some of the most arid and harsh human habitats on earth.

1.2.6 Regional perspective of the sampling zones

Pastoralism by definition is an extensive system of livestock production in which a degree of mobility is incorporated as a strategy to manage production over a heterogeneous landscape characterised by a precarious climate. Because of the need to take full advantage of the landscape, pastoralism is poorly fitted to the rigid structure of national and international boundaries. The pastoral strategy of mobility therefore underscores the need for a regional perspective, especially since other impacts such as spread of disease and livestock rustling are side effects of pastoral mobility. Campbell (1984) noted that some pastoral groups employed similar coping mechanisms. There is therefore a need to document coping mechanisms, and to compare their efficacy among ethnic groups, pastoral categories and agro-ecological zones.

It is evident from the brief description of the pastoral peoples in each zone that there is a diversity of ethnic and pastoral groups across the zones; the pastoral groups range from agropastoralists to pure pastoralists. The map presented in Figure 8 summarises the regional perspective of the survey, showing the predominant type of pastoralists in each area and the various clusters of households surveyed across the whole region.



AP = agropastoralists; PP = pure pastoralists.

Figure 8. *Map providing a regional perspective of the zones included in the survey: the predominant type of pastoralists in each area and the clusters of households surveyed are shown.*

2 Survey results: Impact of the drought and El Niño rains on the environment, and responses of livestock and pastoralists

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This section presents the survey results that relate to: (i) the impact of the climatically stressful periods on the natural resources that pertain to pastoral livelihoods, i.e. water for livestock and human consumption, and forage resources; (ii) herd dynamics; and (iii) human welfare.

Herd dynamics include: average numbers of each major species; birth, purchase, sales and slaughter rates; and disease incidence over the various climatic phases. Herd dynamics therefore reflect the consequences of the environmental pressures, the perceptions of the pastoralists of the risks involved and the attempts by pastoralists to mitigate these pressures.

All results are presented as averages for households in each zone. However, since the S. Kenya and N. Tanzania zones included both agro- and pure pastoralists, where pertinent, the data for these two sub-groups are presented separately. Comparisons are made between the agropastoral zones (C. Tanzania, NW Tanzania and C./SW Uganda, plus the agropastoral areas of S. Kenya and N. Tanzania) and the pure pastoral zones (S. Ethiopia and N. Kenya, plus the pure pastoral subzones of S. Kenya and N. Tanzania).

2.1 Impact of drought and El Niño rains on water and forage resources

The eastern African rangelands are a highly heterogeneous natural resource that is relegated to marginal land characterised by climatic variations, especially prolonged dry periods. In some of these areas, livestock production is the only economic venture that is sustainable. Key inputs into livestock production off the rangeland are water (for both livestock and human consumption) and forage, both of which are highly susceptible to the vagaries of the climate. Tracking of the forage resources and water sources are therefore important facets of the pastoral strategy, affecting the capacity of the pastoralists to produce off the rangelands (Dyson-Hudson 1991; Niamir-Fuller 1998). Livestock on rangelands frequently compete for water and forage resources with wildlife, both within and beyond areas demarcated as wildlife sanctuaries. Wildlife, therefore, place a demand on the same natural resources that support the livelihoods of pastoralists.

2.1.1 Impact of the drought and El Niño rains on water sources for livestock

Tracking of water of consumable quality for livestock is one of the major occupations for pastoralists, and one of the key determinants of pastoral movement and migration. Various types of livestock water sources were used across the zones: boreholes (established by use of drilling equipment), hand dug wells, dug stream beds (excavated dry or sluggish stream beds (see Plate 2); excavation encourages seepage of water), ponds, concrete tanks in the ground, concrete tanks above ground, and reservoirs/dams.

Plate 2. *Livestock drinking at a shallow river.*

Plate 3. *A dry river bed.*

In the arid and semi-arid areas, surface water is scarce and most of these water sources are recharged by rainfall. Other water sources are dependent on underground reservoirs whose supply is unknown and are often affected by insufficient recharge. Water sources, therefore, reflect the climate and thus the number and proximity of the water sources will change with climate. Quality of water is also affected by climatic factors. Extended dry periods result in the drying up of water sources resulting in a dwindling water supply, unfit for livestock and human consumption. Flooding causes excessive runoff from adjacent areas, resulting in disease agents and other pollutants washing into water sources.

Figures 9–17 show the types of water sources used during the pre-drought, peak drought and El Niño phases in each of the individual zones and subzones. In the pre-drought phase, hand dug wells were the most commonly used water sources across zones, with the exception of S. Ethiopia and N. Tanzania where ponds and reservoirs and dams, respectively, were the major water sources. During the drought phase, hand dug wells continued to be the most commonly used water source across zones, with the exception of N. Tanzania and C./SW Uganda where reservoirs and dams were more important. In the drought period, pastoralists resorted to digging streambeds and the use of boreholes, measures that indicated scarcity of water. Pastoralists excavate stream-beds when streams dry out and use of boreholes only when other sources are exhausted because boreholes at some locations carry a mandatory fee.

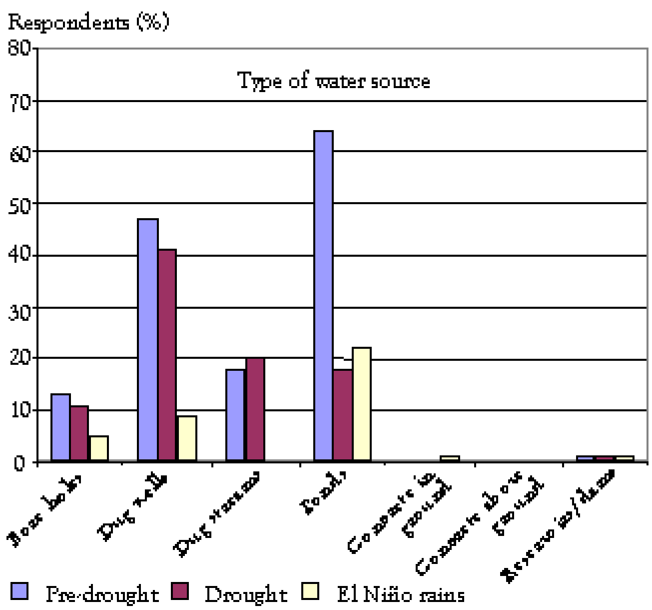

Figure 9. *Percentage of respondents in S. Ethiopia utilising the different kinds of water sources.*

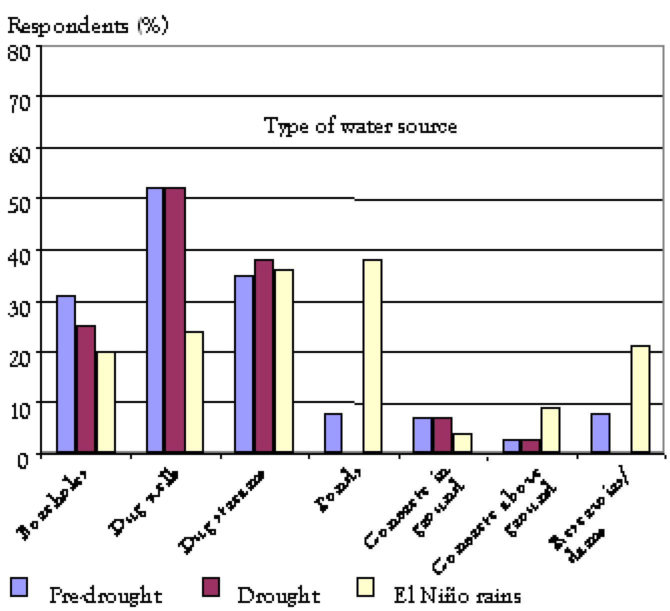

Figure 10. *Percentage of respondents in N. Kenya utilising the different kinds of water*

sources.

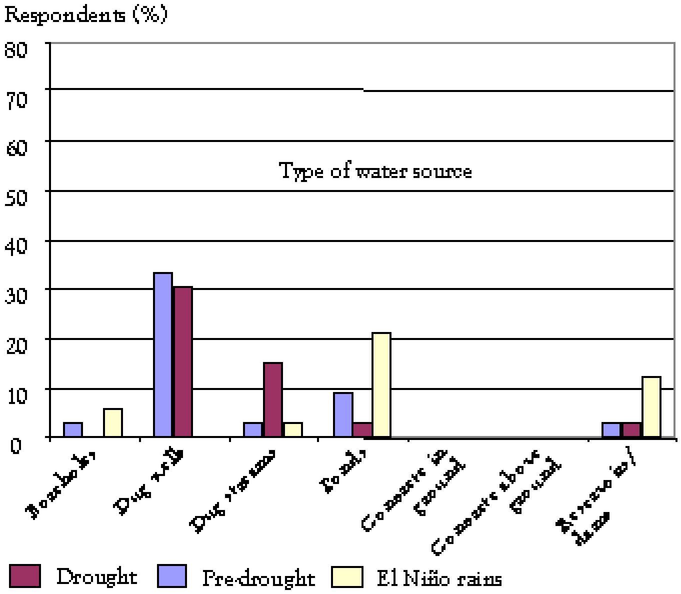

Figure 11. *Percentage of respondents in the S. Kenya agropastoral subzone utilising different types of water sources.*

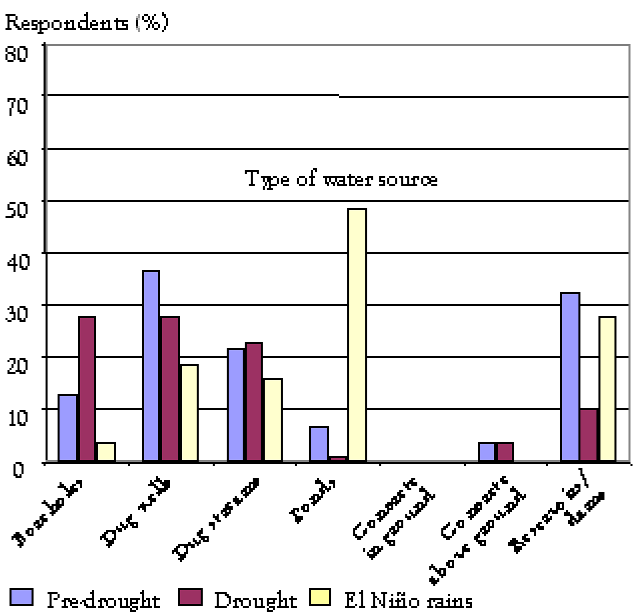

Figure 12. *Percentage of respondents in the S. Kenya pure pastoral subzone utilising different kinds of water sources.*

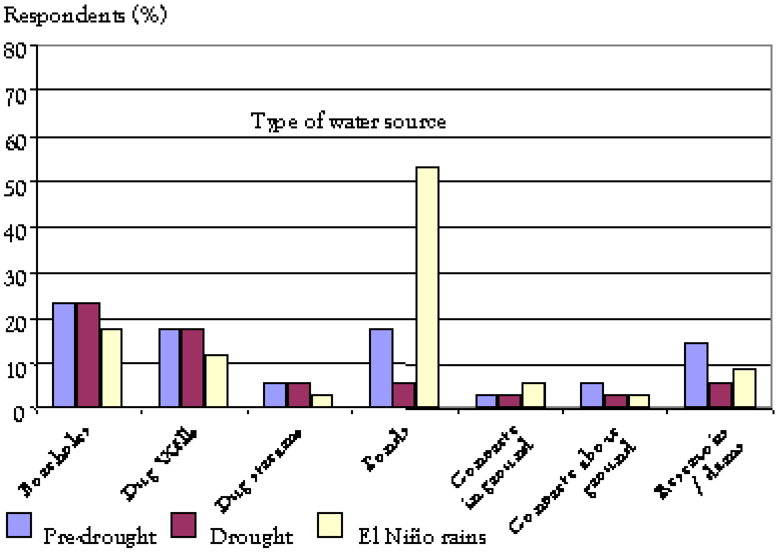

Figure 13. *Percentage of respondents in the N. Tanzania agropastoral subzone utilising different kinds of water sources.*

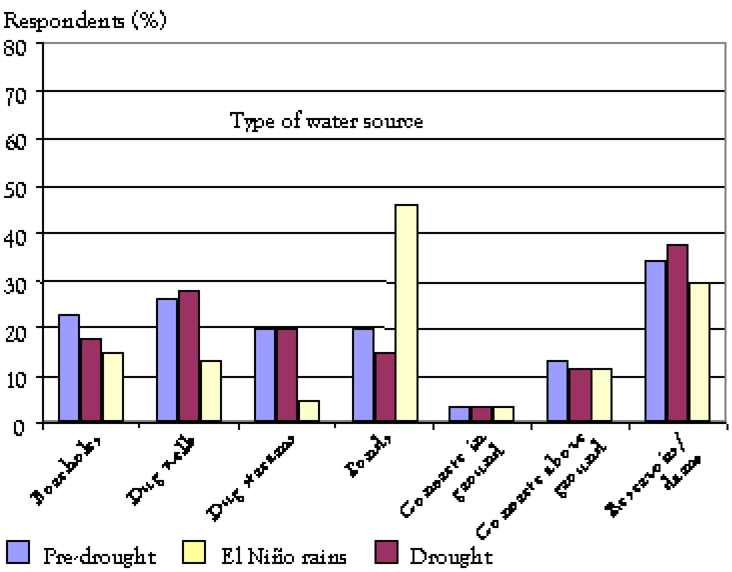

Figure 14. *Percentage of respondents in the N. Tanzania pure pastoral subzone utilising the different kinds of water sources.*

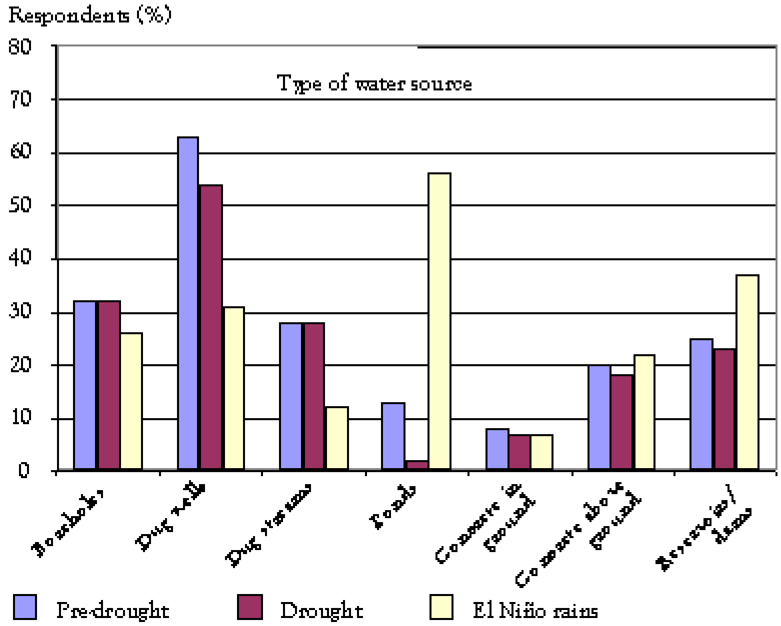

Figure 15. *Percentage of respondents in C. Tanzania utilising the different kinds of water sources.*

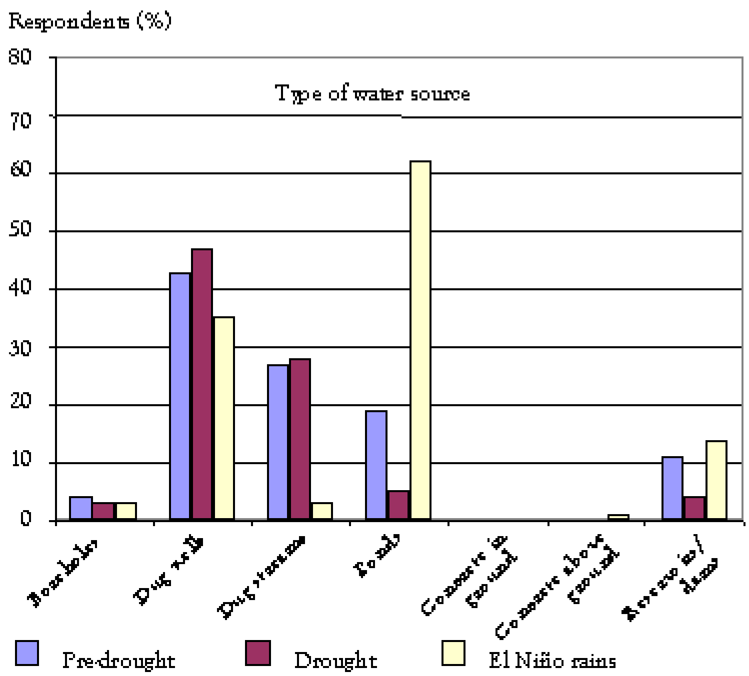

Figure 16. *Percentage of respondents in NW Tanzania utilising the different kinds of water sources.*

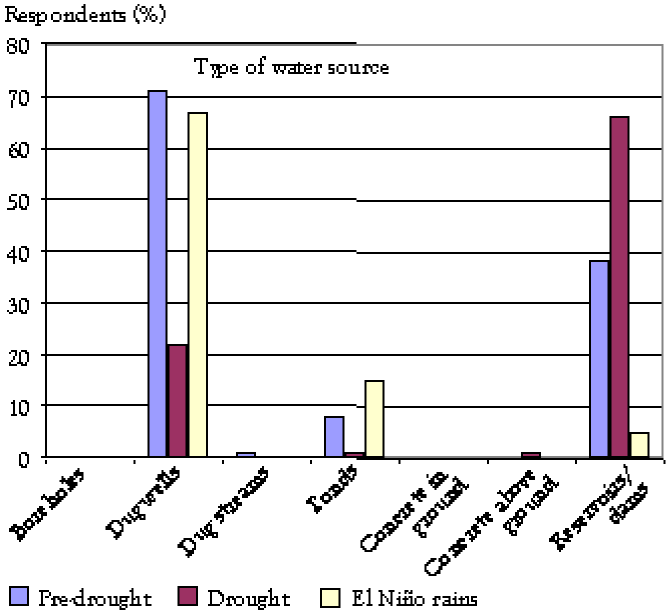

Figure 17. *Percentage of respondents in C./SW Uganda utilising the different kinds of water sources.*

During the El Niño phase, across zones, with the exception of C./SW Uganda, ponds were the dominantly used water sources; whereas in C./SW Uganda, dug wells were the most commonly used water sources.

The mean number of water sources used for livestock by pastoral households in each zone or subzone is provided in Table 5. Two categories of water source were identified in relation to environmental stress: those that were usually accessible to the households (designated as the primary water sources); and those which the pastoralists had to seek out or were made accessible to them as emergency water sources.

Table 5. *Mean number of water sources for livestock during each climatic phase by zone/pastoral category.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	4	2 (1)[2]	5	6 (2)	2
N. Kenya	PP	3	3 (6)	4	5 (2)	2
S. Kenya	AP	1	1 (1)	2	3 (1)	1
S. Kenya	PP	2	1 (5)	2	2 (1)	2
N. Tanzania	AP	2	2 (2)	2	2 (1)	2
N. Tanzania	PP	2	2 (2)	2	4 (2)	2
C. Tanzania	AP	2	1 (1)	5	6 (2)	2
NW Tanzania	AP	2	1 (1)	4	5 (2)	2
C./SW Uganda	AP	2	1 (1)	3	6 (1)	2
Means						
	AP	2	1 (1)	3	4 (1)	2
	PP	3	2 (4)	3	4 (2)	2

1. AP = agropastoral; PP= pure pastoral.
2. Figures in parentheses are emergency sources.

At some locations, primary water sources dried out (see Plate 3) and pastoralists had to utilise the emergency sources. At other locations, emergency sources were used to reduce the burden on the primary sources. There were significantly fewer ($P<0.001$) primary water sources accessible to pastoralists during the drought than during the pre-drought phase in all zones except N. Kenya, S. Kenya and N. Tanzania. Due to additional emergency water sources, N. Kenya had significantly ($P<0.05$) more drought than pre-drought water sources. Differences between total numbers of drought and pre-drought water sources were not significant for S. Kenya and N. Tanzania.

With the onset of the minor rains there was an increase in the number of water sources available for livestock in all zones except N. Tanzania. A further increase was recorded during the El Niño phase, except in S. Kenya pure pastoral areas and N. Tanzania agropastoral areas. In all zones, emergency water sources were used during the El Niño phase, a finding which could reflect contamination of primary sources.

During the La Niña dry phase, the number of water sources used by pastoral households was reduced to the pre-drought level in all zones except S. Ethiopia and N. Kenya. In these two zones, fewer water sources were available during the La Niña dry than during the pre-drought phase. This could reflect the prediction, obtained through normalised difference vegetation index (NDVI) analysis, of another drought for these two zones. In general, the agro- and pure pastoral zones had access to a similar number of water sources; however, in comparison with the agropastoralists, pure pastoralists tended to have slightly more primary water sources available during the pre-drought and drought phases and more emergency livestock water sources during the drought.

The number of water sources for livestock, however, belies true accessibility, as accessibility of a water source must reflect both the presence and distance to the resource. Quality of a water source was a key determinant of trekking distance. Poor quality/ contaminated sources of water which were unacceptable to livestock were abandoned in preference of more distant but better quality sources. Mean distances trekked by livestock to water sources during each of the five climatic phases are indicated in Table 6. Trekking long distances to watering points reduced effective grazing time available to livestock; in some zones, when long trekking distances were necessary the frequency of watering of livestock was reduced to once every three to four days. Coppock (1994) observed that the strategy of restricted watering allows livestock to cover greater radii in search of grazing sites, reduces herding and watering labour and increases the efficiency of water use.

Table 6. *Mean distances (km) trekked by livestock to watering points by zone/pastoral category.*

Zone	Pastoral category1	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	22.4	77.3 (81.3)[1]	2.4	1.3 (3.7)	3.6
N. Kenya	PP	4.7	8.5 (19.2)	2.3	1.3 (3.3)	3.6
S. Kenya	AP	3.9	4.2 (3.5)	2.1	1.6 (1.6)	3.0
S. Kenya	PP	3.4	9.3 (12.9)	3.1	1.5 (1.3)	2.2
N. Tanzania	AP	4.5	7.1 (7.1)	3.1	2.0 (1.5)	2.7
N. Tanzania	PP	8.1	9.2 (5.4)	2.4	1.3 (1.1)	1.9
C. Tanzania	AP	2.9	3.1 (4.1)	2.4	1.3 (3.7)	3.6

NW Tanzania	AP	2.2	3.1 (2.9)	2.3	1.3 (3.3)	3.6
C./SW Uganda	AP	1.4	4.7 (5.8)	2.3	1.2 (3.6)	3.9
Means	AP	3.0	4.4 (4.7)	2.0	1.5 (2.7)	3.4
	PP	9.7	26.1 (29.7)	3.0	1.6 (2.4)	2.8
	Overall	5.9	14.1 (15.8)	2.5	1.4 (2.6)	3.1

1. AP = agropastoral; PP = pure pastoral.

The overall data indicate that during the pre-drought phase, all livestock trekked between 1 and 8 km to water, except in S. Ethiopia where livestock trekked over 22 km. During the drought, all zones had some emergency water sources. Livestock in S. Ethiopia, N. Kenya and C./SW Uganda trekked significantly longer distances ($P<0.001$) to water during the drought than during the pre-drought phase. Moreover, in S. Kenya agropastoral and N. Tanzania agropastoral areas distances to watering points during the drought were also significantly longer ($P<0.05$) than pre-drought distances. Differences were not significant for other zones and pastoral subzones.

The onset of the minor rains dramatically reduced distances to watering points for livestock to below those in the pre-drought period across the zones. Distances to both primary and emergency watering points were reduced further during the El Niño period. In general, the distances to emergency watering points were greater than distances to primary watering points, reflecting a preference for the emergency watering points when primary watering points became contaminated. During the La Niña phase, distances to watering points increased compared with those in the El Niño phase; however, they were still less than the distances trekked in the pre-drought phase, except in NW Tanzania and C./SW Uganda, and the agropastoral zones of C. Tanzania. Across all climatic zones, except the La Niña dry phase, livestock in the pure pastoral areas tended to travel longer distances to watering points than livestock in agropastoral areas. Differences between the distances travelled by livestock in the agro- and pure pastoral areas were decreased following the onset of the minor rains. Livestock in S. Ethiopia, tended to travel far greater distances to watering points than livestock in any of the other zones.

2.1.2 Sources of water for human consumption

In most cases across zones, humans used the same water resources as livestock. However, in some zones, special sources of water such as boreholes were constructed by government agencies and non-governmental organisations (NGOs) to supply water for human use only. These sources of clean water had a mandatory fee, which was a deterrent to some of the pastoralists who opted instead to fetch water from free, though less hygienic sources. Table 7 presents the two most commonly used sources of water for human consumption in each zone during the different climatic phases.

Table 7. *Percentage of respondent households using the two most commonly used water sources during various climatic phases by zone/pastoral category.*

Zone	Pastoral category[1]	Water source	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	Pond	48	14	54	43	56
		River/stream	16	33	18	22	5

N. Kenya	PP	Well	47	58	29	12	36
		River/stream	30	13	23	43	41
S. Kenya	AP	Borehole	20	17	17	17	23
		Well	27	27	10	10	20
S. Kenya	PP	River/stream	25	28	23	25	31
		Well	17	17	19	11	16
N. Tanzania	AP	River/stream	35	32	38	29	38
		Borehole	15	24	17	12	15
N. Tanzania	PP	River/stream	28	26	31	25	25
		Pond	20	21	28	25	25
C. Tanzania	AP	Well	47	38	43	24	40
		Borehole	28	36	29	22	24
NW Tanzania	AP	Well	61	67	61	58	64
		Borehole	13	15	12	10	12
C./SW Uganda	AP	Well	62	33	59	64	64
		Borehole	12	15	12	12	12

1. AP = agropastoral; PP = pure pastoral.

Generally, across zones, hand dug wells were the most commonly utilised source of water for human consumption, being cited as one of the two most commonly used sources for all zones except S. Ethiopia and N. Tanzania. Pastoralists in S. Ethiopia, C. Tanzania, NW Tanzania and C./SW Uganda were heavily reliant upon their main source of water (Table 7). Use of the most common water source decreased with the onset of drought in S. Ethiopia, C. Tanzania and C./SW Uganda; in contrast, it increased for N. Kenya where there was a greater reliance on wells and less reliance on rivers/streams.

During the minor rains, all zones relied increasingly on their most commonly used water source. However, going into the El Niño phase, pastoralists in N. Kenya and C. Tanzania relied less on wells which otherwise tended to be their most commonly used source of water across phases. In N. Kenya there was increased use of rivers and streams and in C. Tanzania increased use of other sources. These changes in behaviour may indicate that wells were more distant to households (in some centralised location) than other sources or that users were charged a mandatory fee. Use of water sources during the La Niña phase was similar to that for the pre-drought phase.

A comparison of the patterns of use of water sources for livestock and human consumption showed similarities across the phases. Generally, with the exception of S. Ethiopia, pastoralists relied on wells for both human and livestock water in the pre-drought and drought phases. With the onset of the minor rains and the El Niño rains, there was a general shift towards usage of ponds, rivers and streams for livestock and domestic water in all zones, except for C. Tanzania, N. Tanzania and C./ SW Uganda where wells were predominant sources of domestic water during these phases.

2.1.3 Impact of the drought and El Niño rains on forage resources

Pastoralists utilise highly heterogeneous landscapes, in terms of forage type and species, forage quality, forage availability (quantity) and terrain. Lateral movement is a key strategy among others utilised by pastoralists to optimise production from the heterogeneous landscape. It is common practice among pastoralists, to designate forage sources as primary grazing sites (i.e. those routinely used during favourable periods and usually located close to the household) or as emergency grazing sites (i.e. those specifically reserved for use during stress periods). In some zones, emergency forage sources include sites that are normally avoided, such as swampy areas or those normally infested with tsetse flies. During the drought, some pastoralists divide herds into core and satellite groups. The core herd includes the breeding stock (pregnant and lactating), and young, old and vulnerable animals. The satellite herd includes the hardy males and nonlactating females, and the larger and hardier livestock species such as cattle and camels. The satellite herds are usually trekked to the emergency grazing sites located further from the households than the primary sites. Table 8 presents the mean distance to forage sources for each zone/pastoral category across climatic phases.

Table 8. *Mean distances (km) travelled to primary and emergency grazing sites for the zones surveyed across the climatic phases.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	15	54 (75)[2]	7	3 (4)	6
N. Kenya	PP	9	22 (46)	6	3 (4)	6
S. Kenya	AP	4	7 (9)	3	2 (2)	4
S. Kenya	PP	4	6 (20)	3	2 (4)	2
N. Tanzania	AP	7	33 (18)	4	2 (2)	3
N. Tanzania	PP	5	8 (12)	4	2 (2)	3
C. Tanzania	AP	2	4 (6)	7	3 (4)	6
NW Tanzania	AP	2	5 (8)	6	3 (4)	6
C./SW Uganda	AP	1	2 (5)	6	3 (3)	7
Means	AP	3	10 (9)	5	3 (3)	5
	PP	8	22 (38)	5	3 (4)	4

1. AP = agropastoral; PP = pure pastoral.
2. Figures in parentheses are distances to emergency grazing sites.

In the pre-drought phase, livestock in S. Ethiopia trekked the longest distances (15 km) and those in C./SW Uganda the shortest distances (1 km) to grazing sites. During this phase, pure pastoralists usually travelled greater distances than agropastoralists (8 vs. 3 km, respectively). The only exception was in N. Tanzania where the agropastoral livestock travelled further in search of grazing than the pure pastoral livestock (7 vs. 5 km, respectively).

During the drought phase, distances travelled to grazing sites increased significantly across all zones ($P<0.001$), with livestock in S. Ethiopia travelling the greatest distances to both primary and emergency grazing sites (54 and 75 km, respectively). Livestock in C./SW Uganda travelled the shortest distances. During the drought, livestock in the pure pastoral areas generally travelled greater distances than livestock in agropastoral areas. The exception, as during the pre-drought phase, was in N. Tanzania where livestock in the agropastoral area travelled much further than those in the pure pastoral areas (33 vs. 8 km to primary sources, respectively).

This anomaly observed in N. Tanzania may partly reflect the much larger size of agropastoral herds compared with pure pastoral herds in that particular zone and the consequent requirement for more forage per herd. In the N. Tanzania zone, in contrast to other zones, distances travelled by agropastoralists to drought emergency grazing sites were much shorter than distances to primary grazing sites. These emergency grazing sites may have been swamps and other landscapes, that pastoralists normally avoid in more favourable periods due to disease infestations.

The minor rains brought great relief to herds, with distances to grazing sites decreasing sharply to below pre-drought distances in all zones, with the exception of C. Tanzania, NW Tanzania and C./SW Uganda. Distances to both primary and emergency grazing sites were decreased further during the El Niño rains phase across all zones. Subsequently, during the La Niña dry phase, distances to grazing sites increased slightly. During the minor rains through to the La Niña dry phase, livestock in the pure pastoral and agropastoral zones on average trekked similar distances to grazing sites.

Pastoralists’ decisions on management strategies are made based on pastoralists’ perception of the situation. Pastoralists have environmental indicators that they use to track forage availability and they translate these signals into appropriate actions. Pastoralists’ perceptions of the sufficiency of forage across the climatic phases are indicated in Table 9 and depicted in Figure 18. In general, the agropastoral areas receive more effective rainfall and produce more forage than the pure pastoral areas. Pastoralists’ perceptions of forage available are therefore discussed in terms of differences between the agro- and pure pastoralists. Incomplete data sets precluded definitive conclusions but nevertheless, strong trends were evident from the data.

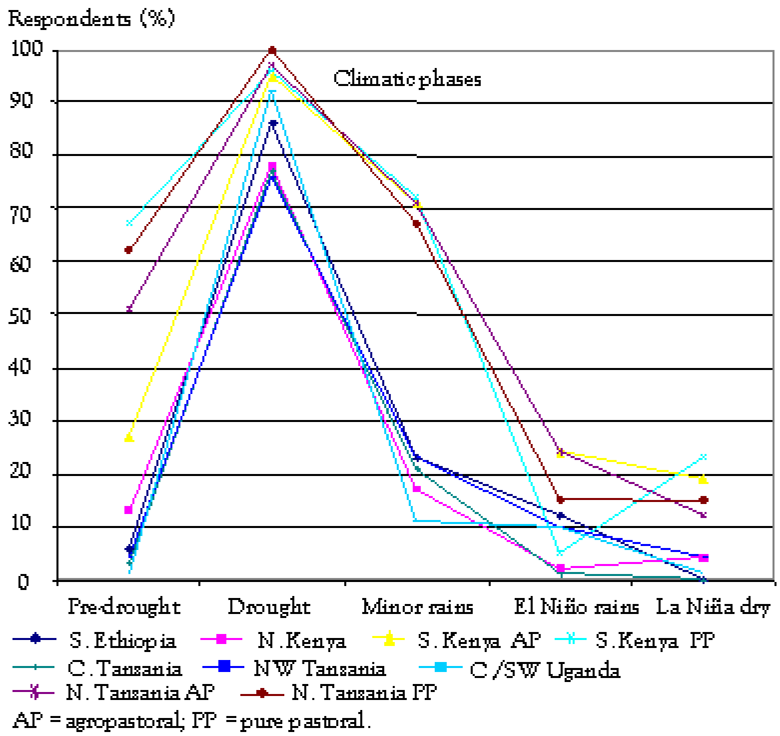

Figure 18. *Percentage of pastoralists who gauged forage as inadequate across climatic phases for each zone.*

Table 9. *Pastoralists’ perceptions (% of respondents) of the sufficiency of available forage across climatic phases for each zone/pastoral group.*

Zone	Pastoral category[1]	Pre-draught				Minor rains			El Niño rains			La Niña dry				
		A[2]	B	C	A	B	C	A	B	C	A	B	C	A	B	C

S. Ethiopia	PP	6	47	14	86	1	0	23	35	0	12	5	16	0	6	14
N. Kenya	PP	13	38	10	78	0	0	17	41	16	2	4	49	4	4	47
S. Kenya	AP	27	73	0	95	5	0	71	29	0	24	4	29	19	3	48
S. Kenya	PP	67	28	5	96	3	1	72	29	0	5	3	63	23	4	35
N. Tanzania	AP	51	49	0	97	3	0	71	9	1	2	4	33	12	2	60
N. Tanzania	PP	62	34	3	100	0	0	67	33	0	1	2	59	15	4	37
C. Tanzania	AP	3	63	3	77	0	0	21	21	1	1	3	39	0	4	35
NW Tanzania	AP	4	60	0	76	4	0	23	29	0	10	4	33	4	5	29
C./SW Uganda	AP	1	45	4	92	3	0	11	41	3	10	5	26	1	7	6
Means	AP	17	58	1	87	3	0	39	26	1	14	4	32	7	4	36
	PP	37	37	8	90	1	0	45	35	4	9	3	47	11	5	33

1. AP = agropastoral; PP = pure pastoral.
2. A = inadequate forage available; B = enough forage available; C = excess forage available.

In the pre-drought phase, most agropastoralists (58%) perceived the forage resource as sufficient but a smaller proportion (17%) began to gauge the forage as inadequate. Very few agropastoralists (about 1%) perceived available forage as being in excess of their needs. Most pure pastoralists perceived the forage resource during the pre-drought phase as either inadequate (37%) or sufficient (37%). However, 8% of pure pastoralists perceived the forage resource as excess. This mainly reflected the perceptions (14% and 10%, respectively) of the pure pastoralists in S. Ethiopia and N. Kenya, two of the most arid zones surveyed. This observation highlights the importance of perception, as each zone, group of pastoralists and indeed each household will designate abundance according to specific characteristics of the local environment, their perception of the deviation from the norm and the amount of risk they are able to tolerate.

Most of the pastoralists, (87% of agropastoralists and 90% of pure pastoralists) characterised the drought phase as one in which forage was marginal and inadequate. The onset of the minor rains brought some relief from the drought, as a few households gauged the forage resource as adequate (26% of agropastoralists and 35% of pure pastoralists). However, the majority of pastoralists in both groups still gauged the forage resource as insufficient. During the El Niño and La Niña dry phases, a greater proportion of agro- and pure pastoralists gauged forage availability as either sufficient or in excess. Nevertheless, there were still pockets of the populations in each zone who perceived the available forage as insufficient. This could reflect, among other factors, the heterogeneity of the landscape and variations in stocking rates.

2.1.4 Livestock/wildlife competition for forage resources

Wildlife compete with livestock for resources on rangelands (see Plate 4). Pastoralists reported that wildlife compromised greatly the carrying capacity of rangelands that they had reserved. This problem is highlighted by results from additional survey questions administered in the N. Tanzania pastoralist zone which assessed the scope and effects of wildlife intrusion on pastoralism and the environment. In this area, more than 90% of respondents reported wildlife intrusion onto their grazing lands. The intruding wildlife species were mainly herbivores (affecting 98% of the respondents) although 59% of the respondents also reported intrusion by carnivores. Most of the intrusion reportedly occurred during drought when the wildlife sought water and forage. The problems caused by wildlife intrusion, in order of importance to the pastoralists (percentage of respondents affected is given in parentheses), were as follows: predation of domestic animals (56%); introduction of livestock diseases (53%); damage to cultivated crops (43%); and competition with livestock for water and forage (28%). The herbivore species were reported to cause losses mainly in forage grass and cultivated crops (67% and 45%, respectively) but little damage to trees (10%). The overall effect of wildlife on plant biodiversity was moderate with only 23% of respondents reporting extinction of important plant species.

Plate 4. *Wildlife grazing alongside livestock in the rangelands.*

Different strategies were used to cope with the wildlife intrusion. While 39% of respondents took no action, 30% trapped or killed the marauding animals and 23% notified the game department. Smaller proportions of respondents guarded their crops or relocated their herds (10% and 3%, respectively); only 3% fenced off their pastures. To cope with increases in disease, the main strategy used was vaccination (53%) followed by veterinary drug treatment (28%), ethnic therapy (13%), notification of extension staff (13%), dipping (11%), herd relocation (4%) and burning of the rangeland (about 2%). About 27% of respondents received no external assistance to cope with diseases. Among those that reported having obtained assistance, the majority (80%) were helped by the government (80%) and a few received help from NGOs (18%). This assistance was mainly in the form of vaccination and advice, although about 3% of pastoralists received veterinary drugs.

Apart from wildlife intrusion, 88% of the respondents reported livestock intrusion onto their grazing lands mainly during drought further aggravating the impact of wildlife on the water and forage resources of the pastoralists and the environment in the long run. To forestall or reduce further damage, it will be necessary to estimate the damage caused and carrying capacity of the grazing lands before devising appropriate interventions. This calls for making an inventory of water points and mapping of grazing reserves as an initial step in that direction.

2.2 Impact of drought and El Niño rains on cattle herd dynamics

Herd dynamics are a reflection of all the events that affected herd numbers (births, sales, purchases, slaughter and mortality) over time.

2.2.1 Cattle herd size

Mean cattle herd size in the various zones throughout the investigated climatic phases is indicated in Table 10. The data indicate that during the pre-drought period, S. Kenya pure pastoralists had the largest cattle herd sizes (average = 149 cattle) while N. Kenya pure pastoralists had the smallest herds. However, the agropastoral zones tended to have more cattle per herd than pure pastoralist zones (overall mean = 71 and 63 cattle/herd, respectively). The most arid zones, S. Ethiopia and N. Kenya, with the greatest vulnerability to drought within the region, had the lowest numbers of cattle per herd.

Table 10. *Mean cattle herd size during each climatic phase and percentage (%) reduction in herd size due to drought and El Niño rains for the zones surveyed.*

Zone	Pastoral category[1]	N[2]	Pre-drought	Peak drought	Minor rains	Peak El Niño rains	La Niña dry	Reduction pre-drought to beginning of minor rains %	Reduction minor rains to La Niña dry %
S. Ethiopia	PP	85	34	31	7	7	8	78	–3.0
N. Kenya	PP	100	11	10	7	8	8	34	–8.0
S. Kenya	AP	33	34	29	24	32	30	30	–23.0
S. Kenya	PP	87	149	125	97	98	79	35	19.0
N. Tanzania	AP	34	125	99	94	95	88	25	6.0
N. Tanzania	PP	61	56	46	43	40	52	23	–23.0
C. Tanzania	AP	87	58	53	53	52	53	9	–1.0
NW Tanzania	AP	100	48	40	39	39	39	20	–0.1
C./SW Uganda	AP	73	92	84	81	83	91	12	–13.0
Means	AP		71	61	58	60	60	19	–6.0
	PP		63	53	39	38	37	43	–4.0
	Overall		67	57	50	50	50	29	–5.0

1. AP = agropastoral; PP = pure pastoral.
2. N = number of households.

There was a reduction in herd size across zones during the drought. Drought herd size was recorded for peak drought and the figure recorded for minor rains was taken for the beginning of the minor rains, i.e. at the end of the drought. Reduction due to drought was therefore calculated as the difference in cattle herd sizes between the beginning of the pre-drought period and the beginning of the minor rains. During the drought, S. Ethiopia recorded the largest reduction in herd size (78%), this was far above the average reduction for all the zones (29%). Decreases in herd sizes were least (9%) in C. Tanzania. In general, the pure pastoral zones recorded greater reductions in cattle herd sizes than the agropastoral zones (43% vs. 19%, respectively).

Herd size was recorded for the peak of the El Niño rains and for the end of the La Niña dry phase. It was therefore not possible to calculate the net reduction/increase in cattle herd size due solely to the El Niño period. Reductions were therefore calculated from the beginning of the minor rains to the end of the delimited La Niña phase. Results in Table 10 indicate that only S. Kenya pure pastoral areas and N. Tanzania agropastoral areas recorded reductions in herd size (19% and 6%, respectively). All the other zones recorded net increases in cattle herd sizes over the same period, with S. Kenya agropastoral and N. Tanzania pure pastoral zones reporting the greatest increases. In general, both the agropastoral and pure pastoral zones recorded net gains between the start of the minor rains phase and the end of the La Niña phase. Overall, pure pastoral zones had almost 25% greater reductions in herd size than agropastoral zones during the drought.

2.2.2 Cattle herd structure

Mean composition of the cattle herds by category throughout the survey period is indicated in Table 11. In general, the herds had a ratio of 1:4:1:1 for bulls:cows:heifers:calves, respectively.

Table 11. *Mean herd structure across climatic phases and ratio of bulls:cows:heifers:calves for the surveyed zones/pastoral categories.*

Zone	Pastoral category[1]	Herd size	% Bulls	% Cows	% Heifers	% Calves	Ratio[2]
S. Ethiopia	PP	17	17	47	17	17	1:3:1:1
N. Kenya	PP	9	14	52	17	17	1:5:1:1
S. Kenya	AP	30	22	49	14	15	2:4:1:1
S. Kenya	PP	110	20	47	17	17	2:4:1:1
N. Tanzania	AP	100	13	57	16	14	1:6:2:1
N. Tanzania	PP	47	17	48	18	17	1:3:1:1
C. Tanzania	AP	54	12	47	21	20	1:4:2:2
NW Tanzania	AP	41	20	40	20	20	1:2:1:1
C./SW Uganda	AP	86	5	52	23	20	1:10:5:4
Means	AP	62	14	49	19	18	1:4:1:1
	PP	46	17	49	17	17	1:4:1:1
	Overall	55	16	49	18	17	1:4:1:1

1. AP = agropastoral; PP = pure pastoral.
2. Bulls:cows:heifers:calves.

However, there were distinct zonal differences in herd structure. C./SW Uganda had the largest ratio of cows to bulls (10:1). Herds in all zones and pastoral areas were female dominated, a herd structure also observed in other pastoral areas (Coppock 1994).

2.2.3 Cattle birth rates

Breeding to ensure proliferation of herd numbers, is a key management goal of pastoralists; it ensures survival of a breeding stock and thus promotion of the mainstay of their livelihood. Gestation length for Bos indicus cattle ranges from 285.8 to 297.7 days (Plasse et al. 1968). Whilst uncontrolled breeding is practised in face of the vagaries of the climate, Coppock (1994) noted that season, a determinant of nutritional status, affects patterns of cattle breeding. For example, in the Borana region of Ethiopia, most calves (70%) are born during the long rains, their arrival coinciding with optimal environmental and nutritional conditions for calf growth and recovery of the cows at the time of their greatest nutritional demands.

Survey data on calving patterns are presented in Table 12. Birth rate was the number of births expressed as a percentage of the number of cows. During the pre-drought period, with the exception of N. Kenya and S. Kenya pure pastoral areas, there were low birth rates across zones. The overall average was 12.9% with NW Tanzania recording the lowest birth rate (6.4%).

Table 12. *Mean birth rates (%) per household in the different zones over the climatic phases.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	9.6	18.0	23.3	37.1	24.4
N. Kenya	PP	19.6	27.2	25.7	32.3	33.4
S. Kenya	AP	17.9	16.9	18.0	12.0	22.9
S. Kenya	PP	18.5	20.2	22.5	29.1	28.6
N. Tanzania	AP	9.6	8.6	11.5	13.0	9.5
N. Tanzania	PP	11.6	21.9	19.9	10.3	11.5
C. Tanzania	AP	12.5	33.6	30.1	34.8	39.6
NW Tanzania	AP	6.4	22.9	35.3	28.3	34.4
C./SW Uganda	AP	8.6	12.2	16.1	13.9	16.1
Means	AP	11.0	18.8	22.2	20.4	24.5
	PP	14.8	21.8	22.9	27.2	24.5
	Overall	12.9	20.3	22.6	23.8	24.5

1. AP = agropastoral; PP = pure pastoral.

During the drought, birth rates increased from pre-drought levels in all areas except N. Tanzania agropastoral areas.

The onset of the minor rains was accompanied by a trend for birth rates to increase slightly in both the agropastoral and pure pastoral areas.

During the El Niño rains phase, all zones, with the exception of S. Kenya agropastoral areas, NW Tanzania, C./SW Uganda, and N. Tanzania pure pastoral areas, recorded an increase in birth rate from the minor rains levels. Peak birth rates were reported in S. Ethiopia, N. Kenya, S. Kenya pure pastoral and N. Tanzania agropastoral zones. The La Niña dry phase was associated with a slight decrease in birth rates in pure pastoral zones and an increase in birth rates in agropastoral zones. Peak birth rates were observed in S. Kenya agropastoral and C. Tanzania zones during the La Niña dry phase.

An overall assessment of data shows that in all zones, some cows calved during each climatic phase, with the lowest birth rate generally occurring during the pre-drought period. Most zones indicated peak birth rate during the period between the start of the minor rains and the end of the La Niña dry phase.

2.2.4 Cattle purchase rates

Cattle purchase rate was calculated as the percentage of a household's cattle purchased during a given climatic phase. As indicated in Table 13, purchase levels for cattle across zones were low, with no pastoralists in any zone purchasing more than an equivalent of 3.9% of their cattle herd during any phase.

Table 13. *Mean cattle purchase rates (%) per household for all zones surveyed across the climatic phases.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	0.6	0.2	0.1	0.2	0.6
N. Kenya	PP	1.0	0.8	0.4	1.1	0.9
S. Kenya	AP	0.2	0.0	0.5	0.0	0.0
S. Kenya	PP	0.9	0.9	0.8	1.1	1.6
N. Tanzania	AP	0.8	0.1	0.4	0.7	0.8
N. Tanzania	PP	2.3	0.6	0.4	0.4	3.9
C. Tanzania	AP	2.0	0.5	0.4	1.0	0.9
NW Tanzania	AP	1.6	0.8	1.4	0.8	2.0
C./SW Uganda	AP	1.7	0.2	0.1	0.0	1.7
Means	AP	1.3	0.3	0.6	0.5	1.1
	PP	1.2	0.7	0.4	0.7	1.8
	Overall	1.2	0.5	0.5	0.6	1.6

1. AP = agropastoral; PP = pure pastoral.

In general, the most purchases were recorded in the pre-drought and La Niña dry phases. Pure pastoralists tended to purchase more cattle than the agropastoralists during the La Niña dry phase. The least purchases were recorded during the drought and minor rains phases, an average of 0.5% of the herd for all zones. Levels of purchase tended to be highest among N. Tanzania pure pastoralists and lowest among S. Kenya agropastoralists.

2.2.5 Cattle sales rates

Cattle sales rate was calculated as the percentage of a household's cattle sold during a given climatic phase. Although mean number of cattle sold per household was low throughout the phases surveyed (average cattle sales rates 3.4–6.1%), sales were higher than purchases. The most sales occurred in the pre-drought and drought phases (see Table 14). Most zones reported their peak cattle sales in the pre-drought phase but N. Tanzania agropastoral areas and NW Tanzania reported peak sales in the drought phase. During the drought, cattle sales decreased across zones, except in N. Tanzania agropastoral areas where the cattle sales increased sharply from 1.9% to 10.7% and NW Tanzania where cattle sales increased slightly from 4.4% to 5.7%.

Table 14. *Mean cattle sales rates (%) for the zones surveyed across the climatic phases.*

	Pastoral					

Zone	category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	10.0	9.3	5.5	4.0	4.7
N. Kenya	PP	7.4	6.1	6.4	6.3	5.2
S. Kenya	AP	3.5	1.6	1.4	0.9	2.9
S. Kenya	PP	4.0	4.0	2.6	2.8	3.6
N. Tanzania	AP	1.9	10.7	2.4	5.8	2.0
N. Tanzania	PP	5.1	4.9	1.7	1.8	2.0
C. Tanzania	AP	8.2	5.9	4.3	4.4	5.6
NW Tanzania	AP	4.4	5.7	1.3	1.3	3.1
C./SW Uganda	AP	8.3	6.4	5.2	4.2	6.2
Means	AP	5.3	6.1	2.9	3.3	4.0
	PP	6.6	6.1	4.0	3.7	3.9
	Overall	5.9	6.1	3.4	3.5	3.9

1. AP = agropastoral; PP = pure pastoral.

Pastoralists reported that they were frustrated when they tried to sell cattle during the drought phase. In S. Kenya for example, they reported that during the drought phase, livestock prices were not worth the walk to the market. At the same time, there were large increases in grain prices. Data collected in S. Kenya indicated that the price of a 100 kg bag of maize increased from 1400 to 7080 Kenya shillings (KSh) (US$ 1 = KSh 58 mean rate for June 1996). The sharp decrease in the value of livestock and concurrent increase in the cost of grain caused a great deal of concern. Some pastoralists in S. Kenya formed local interest groups with the aim of finding marketing solutions. Sales plummeted further with the onset of the minor rains across zones, with the exception of N. Kenya pure pastoral areas. Over the whole region, cattle sales tended to increase slightly during the El Niño rains and La Niña dry phases.

2.2.6 Cattle slaughter rates

Cattle slaughter rate was calculated as the percentage of a household's cattle slaughtered during a given climatic phase. The practice of slaughtering cattle was minimal across zones (Table 15), with no more than 2% of the herd being slaughtered in any zone at any time during the climatic phases surveyed. Slaughter rates were therefore much lower than sales and purchase rates. All zones, except C./SW Uganda, N. Tanzania agropastoral areas and S. Ethiopia recorded their peak slaughter rates in the pre-drought period. The general trend indicated that slaughtering of cattle was greatest in the predrought phase and least in the minor rains phase. Across climatic phases, slaughter rates tended to be highest in S. Ethiopia and lowest in S. Kenya agropastoral areas.

Table 15. *Mean cattle slaughter rate (%) per household, across the climatic phases for all zones surveyed.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	1.2	1.0	1.0	1.9	1.3
N. Kenya	PP	1.3	0.9	0.6	1.1	1.2
S. Kenya	AP	0.2	0.1	0.0	0.0	0.1
S. Kenya	PP	0.4	0.2	0.1	0.3	0.4

N. Tanzania	AP	0.9	1.1	0.9	0.6	0.5
N. Tanzania	PP	1.2	0.5	0.4	0.3	0.3
C. Tanzania	AP	0.6	0.3	0.2	0.3	0.3
NW Tanzania	AP	1.0	0.4	0.5	0.2	0.7
C./SW Uganda	AP	0.5	0.7	0.4	1.5	0.2
Means	AP	0.6	0.5	0.4	0.5	0.4
	PP	1.0	0.7	0.5	0.9	0.8
	Overall	0.8	0.6	0.5	0.7	0.6

1. AP = agropastoral; PP = pure pastoral.

In summary, sales, purchase and slaughter of cattle were practised minimally across the surveyed zones over the climatic phases studied. In general, there were lower purchase rates than sales rates, and even lower slaughter rates.

2.2.7 Cattle disease incidence

The investigation focused on epidemic and parasitic/viral diseases which were observed by the respondents during the drought and El Niño rains. Proportions of respondents that reported cattle disease incidence are shown in Table 16. There was generally a higher incidence of disease in the drought phase than in the El Niño rains phase. Parasitic/viral diseases were prevalent during both phases. During the drought phase, pure pastoral areas tended to report more diseases than agropastoral areas, the reverse was true for the El Niño rains phase.

Table 16. *Percentage of respondents reporting cattle disease incidence during the drought and El Niño rains in the zones surveyed.*

Climatic phase	Zone	Pastoral category1	Epidemic/ infectious	Parasitic/viral
Drought	S. Ethiopia	PP	91	82
	N. Kenya	PP	67	29
	S. Kenya	AP	52	52
	S. Kenya	PP	36	36
	N. Tanzania	AP	68	77
	N. Tanzania	PP	64	69
	C. Tanzania	AP	68	72
	NW Tanzania	AP	40	50
	C./SW Uganda	AP	62	90
	Means	AP	58	68
		PP	65	54
El Niño rains	S. Ethiopia	PP	20	19
	N. Kenya	PP	43	14
	S. Kenya	AP	49	55
	S. Kenya	PP	47	56
	N. Tanzania	AP	59	62
	N. Tanzania	PP	57	64
	C. Tanzania	AP	59	61

	NW Tanzania	AP	40	48
	C./SW Uganda	AP	56	70
	Means	AP	53	59
		PP	42	38

1. AP= agropastoral; PP= pure pastoral.

During the drought phase, the highest incidence of cattle diseases was observed in the S. Ethiopia zone; in contrast, during the El Niño rains, this zone showed the lowest disease incidence.

In northern Kenya, closer investigations showed that Rift Valley fever was one of the major infectious diseases which affected the human and livestock populations during the El Niño rains.

2.2.8 Cattle mortality

Mortality is defined as death of livestock due to factors other than slaughtering. Mortality was calculated as the number of deaths that occurred in a given phase expressed as a percentage of herd size during the previous phase. Mean cattle herd mortality across the climatic phases for each zone is indicated in Table 17 and Figure 19. In general, across zones, higher mortality levels occurred in the drought phase than other phases; cattle mortality during the El Niño phase was also high. Pure pastoral zones tended to record higher mortality rates than agropastoral zones.

Table 17. *Mean cattle herd mortality (%) per household in the different zones over the climatic phases surveyed.*

Zone	Pastoral category[1]	Drought	Minor rains	El Niño rains	La Niña dry	Mortality (%) due to	
						Drought	El Niño rains
S. Ethiopia	PP	45.5	2.5	28.6	11.0	48.6	36.9
N. Kenya	PP	29.6	5.0	9.0	4.5	35.2	17.3
S. Kenya	AP	9.7	3.1	14.9	10.1	13.4	26.0
S. Kenya	PP	26.3	8.6	20.4	5.3	36.2	29.4
N. Tanzania	AP	18.2	2.7	24.4	2.1	28.0	10.1
N. Tanzania	PP	21.6	9.0	5.6	3.3	24.6	22.0
C. Tanzania	AP	10.0	7.6	9.5	5.3	18.8	17.2
NW Tanzania	AP	11.2	4.5	6.4	4.7	15.3	12.0
C./SW Uganda	AP	9.5	4.4	2.4	3.1	16.8	8.8
Means	AP	11.7	4.4	11.5	5.0	18.5	14.8
	PP	30.7	6.3	15.9	6.0	36.2	26.4
	Overall	20.2	5.3	13.5	5.5	26.3	20.0

1. AP = agropastoral; PP = pure pastoral.

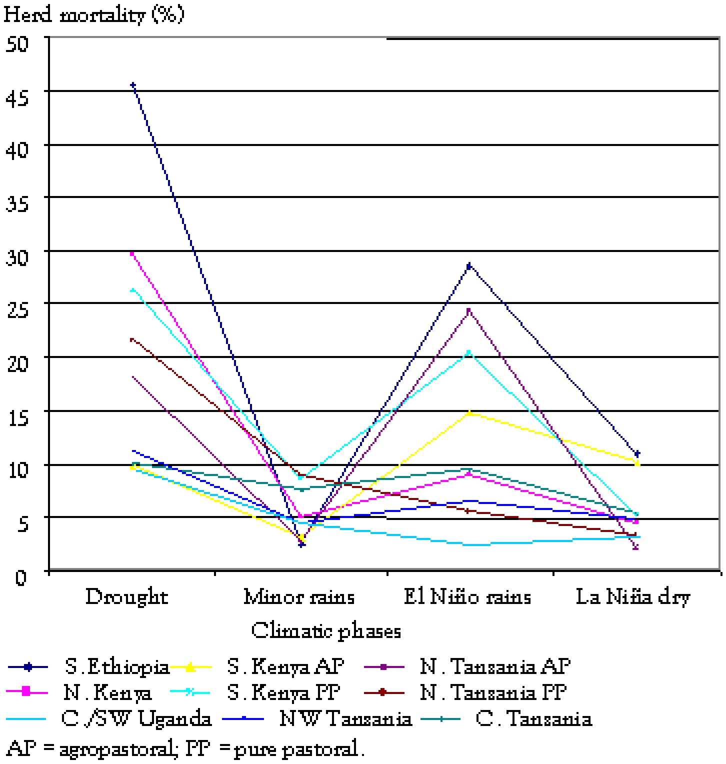

Figure 19. *Mean cattle herd mortality (%) per household in the different zones over the climatic phases surveyed.*

Peak mortality rates occurred in the drought phase for all zones with the exception of S. Kenya and N. Tanzania agropastoral areas where peak mortalities were recorded in the El Niño phase.

Mortality due to the drought was calculated as the total number of deaths in the drought phase plus those in the minor rains phase, as a percentage of pre-drought herd size. Likewise, mortality due to the El Niño rains was calculated as the total number of deaths during the El Niño rains phase plus those during the La Niña dry phase, as a percentage of the minor rains herd size.

Data resulting from these calculations (Table 17) indicate that the cattle herds in S. Ethiopia were the most severely affected by the drought and those in S. Kenya agropastoral areas the least. The most severe cattle mortalities due to the El Niño rains were also experienced by herds in S. Ethiopia, while C./SW Uganda and NW Tanzania experienced the lowest levels of cattle mortality due to the El Niño rains.

2.2.9 Cattle mortality rates by cattle category

Cattle mortality during the drought and El Niño phases was also examined for each zone by cattle category (i.e. bulls, cows, heifers and calves). Mortalities during the drought and El Niño rains phases for each cattle category, as a percentage of that category and as a percentage of the whole herd are presented in Table 18.

Table 18. *Mortality amongst each cattle category as a percentage of category and as a percentage of the total herd.*

Climatic		Pastoral [1]	Bull mortality		Cow mortality		Heifer mortality		Calf mortality		Total herd mortality
			% of	% of	% of	% of	% of	% of	% of	% of	

phase	Zone	category	bulls	herd	cows	herd	heifers	herd	calves	herd	(%)
Drought	S. Ethiopia	PP	52	10	44	21	30	5	58	10	46
	N. Kenya	PP	15	2	28	15	18	3	63	9	30
	S. Kenya	AP	9	2	8	3	4	1	21	4	10
	S. Kenya	PP	26	5	23	11	17	3	45	7	26
	N. Tanzania	AP	16	2	13	7	14	3	43	7	18
	N. Tanzania	PP	21	2	20	10	21	3	26	5	22
	C. Tanzania	AP	11	1	7	3	8	2	19	4	10
	NW Tanzania	AP	6	1	12	5	5	1	21	4	11
	C./SW Uganda	AP	11	1	8	4	4	1	21	4	10
El Niño rains	S. Ethiopia	PP	13	2	35	15	11	3	44	9	29
	N. Kenya	PP	13	2	7	4	6	1	16	2	9
	S. Kenya	AP	44	11	4	2	0	0	12	1	15
	S. Kenya	PP	56	11	10	5	6	1	21	3	20
	N. Tanzania	AP	20	3	30	18	9	1	15	2	24
	N. Tanzania	PP	4	1	2	1	7	1	14	2	6
	C. Tanzania	AP	9	1	7	3	7	2	20	4	9
	NW Tanzania	AP	2	1	5	2	2	0	18	4	6
	C./SW Uganda	AP	6	0	1	1	1	0	7	2	2

1. AP= agropastoral; PP= pure pastoral.

Southern Ethiopia

In S. Ethiopia, where the mean herd ratio of bulls:cows:heifers:calves was 1:3:1:1, there were more deaths due to the drought than the El Niño rains (Table 18). In both the drought and El Niño rains phases, cows constituted the most mortalities (21% and 15% of the total herd, respectively), partly because cows constituted the largest category in the herds. When mortality amongst each cattle category was expressed as a percentage of that category, data indicated that calves were the most vulnerable category, both during the drought and the El Niño rains. During the drought phase, 58% of calves and 52% of bulls died compared with 44% of cows; during the El Niño rains phase, 44% of calves compared with 35% of cows died.

Northern Kenya

In N. Kenya, the mean herd ratio across the climatic phases was 1:5:1:1 for bulls:cows:heifers:calves. The mortality pattern was similar to that in S. Ethiopia with more mortalities in the drought phase than during the El Niño rains phase and with cows constituting the most mortalities as a percentage of the total herd. But as for S. Ethiopia, in the drought phase a greater percentage of the calves (63%) died as compared with the other categories (Table 18). Calves were also the most vulnerable category in the El Niño phase.

Southern Kenya agropastoral areas

S. Kenya agropastoral areas had a mean herd ratio of 2:4:1:1 for bulls:cows:heifers: calves; thus, having one of the highest bull:cow ratios and more bulls than heifers or calves. In the drought phase, calves were more vulnerable than other cattle categories; 21% of the calves died (equivalent to 4.0% of the herd). However, bulls were the most vulnerable category in the El Niño phase; 44% of the bulls died (equivalent to 11% of the herd).

Southern Kenya pure pastoral areas

The mean herd ratio of bulls:cows:heifers:calves for S. Kenya pure pastoral areas was 2:4:1:1. There were generally higher mortalities in the drought phase than in the El Niño phase (26% vs. 20% of the herd, respectively) (Table 18). The mortality pattern was similar to that of S. Kenya agropastoral areas. Although more cows died, calves were the most vulnerable category in the drought phase; 45% of the calves died compared with only 23% of the cows (Table 18). As in S. Kenya agropastoral zones, bulls were the most vulnerable category during the El Niño phase; 56% of the bulls died.

In S. Kenya, (agro- and pure pastoral) bull mortality was higher during the El Niño rains than during the drought period.

Northern Tanzania agropastoral areas

The mean herd ratio of bulls:cows:heifers:calves in N. Tanzania agropastoral areas was 1:6:2:1, therefore cows constituted the largest part of the herd. There were similar total herd mortality rates in the drought and El Niño phases (18% and 24%, respectively). During the drought, calf and cow mortalities, expressed as a percentage of the herd, were equal; however, calves were a more vulnerable category as 43% of the calves died compared with only 13% of the cows (Table 18). In the El Niño phase, cows were the most vulnerable category.

Northern Tanzania pure pastoral areas

The mean herd ratio of bulls:cows:heifers:calves in N. Tanzania pure pastoral areas was 1:3:1:1, therefore cows constituted the largest part of the herd. There were generally higher mortality rates in the drought phase than the El Niño phase, with cows constituting the most mortalities (Table 18). However, calves were the most vulnerable category during the drought phase; 26% of the calves died compared with 20% of the cows. Total cattle mortality in the El Niño phase was very low (6% of the herd); calves were the most vulnerable category (14% died).

Central Tanzania

C. Tanzania had a mean herd ratio of 1:4:2:2 for bulls:cows:heifers:calves across climatic phases. In general mortality rates were low, with similar mortalities in the drought and El Niño phases. In both phases, calves were the most vulnerable category and contributed the most to the total herd mortality (Table 18).

North-western Tanzania

The mean herd ratio of bulls:cows:heifers:calves across climatic phases in NW Tanzania was 1:2:1:1; this was the highest bull to cow ratio observed in the study region. In general, mortality rates were low, with more mortalities in the drought phase than the El Niño phase. More cows constituted the most mortalities in the drought phase but calves were most vulnerable (21% of the calves died compared with 12% of the cows). Calves were also the most vulnerable cattle category in the El Niño phase (Table 18).

Central/south-western Uganda

The mean herd ratio of bulls:cows:heifers:calves in C./SW Uganda was 1:10:5:4; thus, this zone had more cows per bull than any of the other zones. There was much higher mortality in the drought phase than in the El Niño phase. Throughout the region, C./ SW Uganda had the lowest mortality rates, with total herd mortalities of 10% and 2% during the drought and El Niño phases, respectively (Table 18).

During the drought phase, more cows than other cattle categories died but calves were the most vulnerable group; 21% of the calves died compared with 8% of the cows. Calves were also the most vulnerable category during the El Niño phase; 7% of the calves died.

2.3 Small ruminant herd dynamics

Small ruminants, sheep and goats, were assessed together. Herd dynamics assessed included herd size, and birth, sales, purchase, slaughter and mortality rates. Small ruminant data are presented for all zones except NW Tanzania.

2.3.1 Small ruminant herd size

Small ruminant herd numbers for each zone across the climatic phases surveyed are presented in Table 19.

Table 19. *Mean small ruminant herd size per household during the climatic phases surveyed, and percentage reduction in herd size due to drought and El Niño rains.*

Zone	Pastoral category[1]	N[2]	Pre-drought	Peak drought	Minor rains	El Niño rains	La Niña dry	% reduction: pre-drought to beginning of minor rains	% reduction: minor rains to La Niña dry
S. Ethiopia	PP	85	40	32	7	5	8	83	14*
N. Kenya	PP	100	78	70	66	60	46	15	30
S. Kenya	AP	33	43	46	41	48	36	5	12
S. Kenya	PP	87	271	229	195	184	147	28	25
N. Tanzania	AP	34	156	137	125	118	84	20	33
N. Tanzania	PP	61	110	87	83	74	97	25	17*
C. Tanzania	AP	87	39	37	33	35	30	15	9
C./SW Uganda	AP	73	3	3	3	2	2	0	33
Means	AP		60	55	51	51	38	16	22

	PP		125	105	88	81	75	30	6
	Overall		92	80	69	66	56	25	14

1. AP = agropastoral; PP = pure pastoral.
2. N = number of households surveyed.
* Net increase rather than decrease.

With an average of 271 animals per household, S. Kenya pure pastoral areas had the largest herds of small ruminants, while with only 3 small ruminants per household C./SW Uganda had the smallest herds. In general, the pure pastoralists had more small ruminants than agropastoralists (averages of 125 and 60 animals/household, respectively). This trend was the opposite of that for cattle ownership, where in general, agropastoralists owned slightly more cattle than pure pastoralists. The neighbouring zones of S. Kenya and N. Tanzania owned the largest numbers of small ruminants per house hold. S. Ethiopia, N. Kenya, S. Kenya agropastoral areas and N. Tanzania pure pastoral areas had more small ruminants than cattle in their livestock herds. C./SW Uganda had very few small ruminants, indicating that small ruminants were not an important live stock species in this zone.

During the drought, small ruminant herd sizes decreased greatly, with a reduction across zones with the exception of C./SW Uganda. S. Ethiopia recorded the largest reduction (83%) from pre-drought herd size. Across sites, small ruminant herd sizes continued to decrease going into the El Niño phase, with only the S. Kenya agropastoral areas and C. Tanzania indicating very modest recoveries. The La Niña phase saw a further reduction in small ruminant herd size across zones, with only S. Ethiopia and N. Tanzania pure pastoral areas indicating recovery; reductions tended to be greater in agropastoral zones than in pure pastoral zones. Small ruminant herd data contrasted with data for cattle herds as cattle herds across zones, except for S. Kenya pure pastoral areas and N. Tanzania agropastoral areas, were indicating recovery in the minor rains to La Niña phases even though numbers remained below those pre-drought.

Small ruminant herd sizes were reduced less than cattle herd sizes by the drought; overall average reductions in herd sizes were 25% and 29%, respectively, between the pre-drought phase and the beginning of the minor rains phase. The decline was on average 14% higher in pure pastoral areas compared with agropastoral areas. Cattle herd sizes, however, indicated recovery between the minor rains and the La Niña dry phase with an overall average gain of 5%, while small ruminant herds continued to decrease in size by an average of 14%. The decline was, however, less by 16% on average in pure pastoral areas compared with agropastoral areas.

2.3.2 Small ruminant herd structure

The mean herd composition throughout the climatic phases surveyed is presented in Table 20. The mean herd structure ratios indicate that, in general, there were three ewes to a ram and five does to a buck; thus, females dominated the herds. Moreover, there were generally more goats in the herds than sheep. These observations are in line with the known prolific nature of goats, and the hardiness and adaptability of their physiological make-up, which make them suitable for the highly heterogeneous and harsh conditions of the eastern African rangelands.

Table 20. *Small ruminant herds structure: mean number (no.) of animals per herd across phases; percentage contribution of each category to the composition of the herd; and ratio of rams:ewes:replacement ewes:lambs:bucks:does:female replacement goats:kids.*

Zone and pastoral	Mean no. of			2				2		Ratio

category[1]	animals per herd	Rams (%)	Ewes (%)	R/E (%)	Lambs (%)	Bucks (%)	Does (%)	RFG (%)	Kids (%)	R:E:R/E:L:B:D:RFG:K[2]
S. Ethiopia PP	19	7	15	8	5	8	33	11	13	1:3:1:1:1:6:2:2
N. Kenya PP	64	8	23	4	8	10	32	5	11	2:5:1:2:2:7:1:3
S. Kenya AP	43	4	12	4	4	10	40	11	15	1:3:1:1:3:11:3:4
S. Kenya PP	205	6	24	9	11	6	25	9	10	1:4:2:2:1:4:2:2
N. Tanzania AP	124	5	12	4	4	11	37	15	12	1:3:1:1:3:10:4:3
N. Tanzania PP	90	9	20	6	7	12	29	8	9	2:4:1:1:2:5:1:1
C. Tanzania AP	35	3	10	4	5	10	36	16	16	1:3:1:2:3:11:5:5
C./SW Uganda AP	2	12	12	5	7	10	26	13	14	2:3:1:1:2:5:3:3
Means										
AP	51	6	12	4	5	10	35	14	14	1:3:1:1:3:9:4:3
PP	95	7	21	7	8	9	30	8	11	1:3:1:1:1:4:1:1
Overall	73	7	17	6	7	10	33	11	13	1:3:1:1:1:5:2:2

1. AP = agropastoral; PP= pure pastoral.
2. R = rams; E = ewes; R/E = replacement ewes; L = lambs; B = bucks; D = does; RFG = replacement female goats; K = kids.

Analysis on the basis of pastoral category, indicated that overall the agropastoralists and pure pastoralists kept similar ratios of sheep categories; however, there were pronounced differences in the ratios of goat categories. In general, agropastoral areas had more goats per herd than pure pastoral areas and more bucks to does, with one buck to every three does. The highest bucks:does ratio was in S. Ethiopia, where there was one buck to every six does.

2.3.3 Small ruminant births (lambing and kidding rates)

Birth rate was the number of births expressed as a percentage of the number of ewes or does. Small ruminant birth rates were generally higher than those of cattle across the climatic phases (Table 21). In general, levels of births pre-drought were the lowest, with C./SW Uganda recording no births and N. Kenya the most (N. Kenya recorded the highest birth rates across the climatic zones).

Table 21. *Mean percentage birth rate (lambing and kidding) per household in the different zones over the climatic phases surveyed.*

Zone	Pastoral category1	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	3.6	25.2	20.1	16.2	21.3
N. Kenya	PP	37.4	47.5	52.1	47.0	58.9

S. Kenya	AP	20.4	18.0	15.7	14.9	23.8
S. Kenya	PP	32.0	27.0	27.9	32.0	24.8
N. Tanzania	AP	33.8	21.7	29.8	21.8	41.6
N. Tanzania	PP	16.7	19.6	15.9	19.7	18.1
C. Tanzania	AP	10.3	38.9	40.2	38.9	41.9
C./SW Uganda	AP	0.0	32.4	31.4	35.5	43.7
Means	AP	16.1	27.8	29.3	27.8	37.8
	PP	22.4	29.8	29.0	28.7	30.8
	Overall	19.3	28.8	29.2	28.3	34.3

1. AP= agropastoral; PP= pure pastoral.

In general, birth rates increased during the drought phase and remained steady at these levels during the El Niño rains phase. Birth rates tended to increase slightly from El Niño levels during the La Niña phase when most zones recorded their peak birth rates.

2.3.4 Small ruminant purchase rates

Small ruminant purchase rate was calculated as the percentage of a household's small ruminants purchased during a given climatic phase. Like cattle purchases, small ruminant purchases were low throughout the climatic phases, with no zone recording purchase of more than 4.3% of their herd during any phase (Table 22). In general, most small ruminant purchases occurred in the pre-drought and El Niño phases, with pure pastoral areas purchasing more small ruminants than agropastoral areas.

Table 22. *Mean small ruminant purchase rates (%) for all zones surveyed across climatic phases.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	1.1	0.4	0.0	1.0	4.3
N. Kenya	PP	2.6	1.1	1.3	1.1	1.3
S. Kenya	AP	0.6	0.7	0.1	4.3	0.2
S. Kenya	PP	1.2	0.8	1.8	0.9	1.3
N. Tanzania	AP	1.6	0.0	0.0	0.2	0.1
N. Tanzania	PP	0.8	0.2	0.3	0.6	0.4
C. Tanzania	AP	0.3	0.5	0.2	1.2	0.3
C./SW Uganda	AP	0.0	0.0	0.0	0.0	0.0
Means	AP	0.6	0.3	0.1	1.4	0.2
	PP	1.4	0.6	0.8	0.9	1.8
	Overall	1.0	0.5	0.5	1.1	1.0

1. AP = agropastoral; PP= pure pastoral.

The lowest levels of purchases tended to be recorded in the drought and minor rains phases. There was no distinct purchase pattern across zones but, in general, all zones recorded reduced purchases during the drought and minor rains phases, and increased purchases with the onset of the El Niño rains.

2.3.5 Small ruminant sales rates

Small ruminant sales rate was calculated as the percentage of a household's small ruminants sold during a given climatic phase. Small ruminant sales rates were higher than purchase rates (Table 23). As for cattle sales, most zones recorded their highest sales rates during the pre-drought phase; however, two zones, S. Ethiopia and N. Tanzania agropastoral areas, recorded peak sales during the drought.

Table 23. *Mean small ruminant sales rates (%) for the zones surveyed across the climatic phases.*

Zone	Pastoral category1	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	9.6	11.3	5.2	6.2	5.5
N. Kenya	PP	7.3	7.2	5.2	4.2	4.3
S. Kenya	AP	6.8	11.2	0.7	1.6	11.5
S. Kenya	PP	7.1	6.7	3.3	3.0	3.1
N. Tanzania	AP	4.6	6.2	2.9	2.2	2.7
N. Tanzania	PP	4.4	3.2	1.4	2.7	2.2
C. Tanzania	AP	7.8	6.5	5.0	5.1	2.5
C./SW Uganda	AP	9.5	25.5	14.0	19.6	29.8
Means	AP	7.2	12.4	5.7	7.1	11.6
	PP	7.1	7.1	3.8	4.0	3.8
	Overall	7.1	9.7	4.7	5.6	7.7

1. AP= agropastoral; PP= pure pastoral.

C./SW Uganda and S. Kenya agropastoral zones recorded peak sales during the La Niña phase. In general, agropastoralists recorded higher sales rates than pure pastoralists.

2.3.6 Small ruminant slaughter rates

Small ruminant slaughter rate was calculated as the percentage of a household's small ruminants slaughtered during a given climatic phase. Slaughter rates for small ruminants were much higher than for cattle (Table 24), indicating that in general, pastoralists prefer to slaughter small ruminants rather than cattle.

Table 24. *Mean small ruminant slaughter rates (%) per household, across the climatic phases, for all the zones surveyed.*

Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	4.0	2.6	1.4	1.7	1.7
N. Kenya	PP	6.4	5.9	2.5	1.8	2.7
S. Kenya	AP	1.9	1.7	2.5	2.0	2.0
S. Kenya	PP	2.8	1.6	1.5	1.5	1.3
N. Tanzania	AP	3.6	0.0	1.1	0.1	0.9
N. Tanzania	PP	1.7	0.4	0.5	0.2	0.3
C. Tanzania	AP	2.9	5.4	0.6	0.9	0.5

C./SW Uganda	AP	0.3	5.1	0.0	0.8	2.6
Means	AP	2.2	3.0	1.1	1.0	1.5
	PP	3.7	2.6	1.5	1.3	1.5
	Overall	2.9	2.8	1.3	1.1	1.5

1. AP = agropastoral; PP = pure pastoral.

Slaughter rates were highest during the pre-drought and drought phases, when all zones, with the exception of S. Kenya agropastoral areas, recorded their peak slaughter rates. Overall mean slaughter rates were lowest during the El Niño phase. Slaughter rates tended to be higher in the pure pastoral zones than the agropastoral zones. The pattern of slaughter of small ruminants was correlated with meat consumption patterns.

2.3.7 Small ruminant mortality

Mortality was calculated as the number of deaths that occurred in a given phase expressed as a percentage of herd size during the previous phase. Mortality due to the drought was calculated as the total number of deaths in the drought phase plus those in the minor rains phase, as a percentage of pre-drought herd size. Likewise, mortality due to the El Niño rains was calculated as the total number of deaths during the El Niño rains phase plus those during the La Niña dry phase, as a percentage of the minor rains herd size. As indicated by Table 25 and Figure 20, the mortality pattern for small ruminants was similar to that of cattle. Across all zones, mortalities increased during the stress periods of the drought and El Niño rains. During the El Niño rains, for all zones except S. Ethiopia, mortalities were higher among small ruminants than cattle due to greater susceptibility of small ruminants to diseases such as CCPP. As with cattle, pure pastoral areas reported higher mortalities than agropastoral areas.

Table 25. *Mean small ruminant herd mortality (%) during the drought, the minor rains, the El Niño rains and the La Niña dry phases.*

Zone	Pastoral category[1]	Drought	Minor rains	El Niño rains	La Niña dry	% mortality due to Drought	% mortality due to El Niño rains
S. Ethiopia	PP	41	5	11	12	52	20
N. Kenya	PP	33	16	41	17	43	52
S. Kenya	AP	10	2	38	6	11	39
S. Kenya	PP	13	9	34	5	21	38
N. Tanzania	AP	16	5	4	10	26	19
N. Tanzania	PP	18	8	7	6	26	13
C. Tanzania	AP	16	10	20	8	24	30
C./SW Uganda	AP	9	10	8	6	22	13
Means	AP	13	7	19	8	21	25
	PP	26	10	23	10	36	31
	Overall	20	8	21	9	31	26

1. AP= agropastoral; PP= pure pastoral.

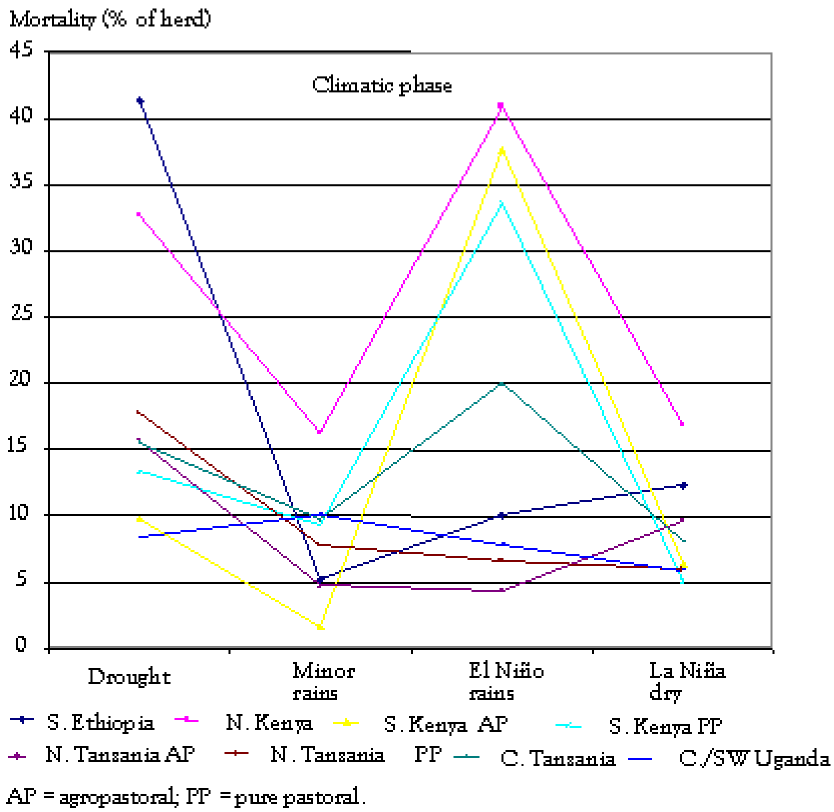

Figure 20. *Mean small ruminant mortality per household in the different zones over the climatic phases surveyed.*

During the drought phase, S. Ethiopia had the highest mortality rates and C./SW Uganda the lowest. During the El Niño phase, the highest mortality rates were experienced in N. Kenya and lowest in N. Tanzania agropastoral areas. Results support those of Traoré and Wilson (1988) who observed that during heavy rains, disease is the greatest constraint to small ruminant production.

2.3.8 Small ruminant mortality rates by category

Small ruminant mortalities during the drought and El Niño rains phases were determined for each small ruminant category, as a percentage of that category and as a percentage of the whole herd. Categories assessed were rams, ewes, replacement ewes and lambs for sheep; bucks, does, replacement female goats and kids for goats. Mortality rates observed for each of the small ruminant categories in each zone during the drought and El Niño rains are presented in Table 26. Figures are given for mortality of each category, as a percentage of that category and as a percentage of the total herd.

Table 26. *Mortality amongst each small ruminant category, as a percentage of category and as a percentage of the total herd.*

Phase and zone and pastoral category[1]	Ram mortality		Ewe mortality		R/E[2] mortality		Lamb mortality		Buck mortality		Doe mortality		RFG[3] mortality		Kid mortality		Total herd mortality (%)
	% of rams	% of herd	% of ewes	% of herd	% of R/E	% of herd	% of lambs	% of herd	% of bucks	% of herd	% of does	% of herd	% of RFG	% of herd	% of kids	% of herd	
Drought																	
S. Ethiopia	66	4.0	48	8.0	81	6.0	59	3.0	26	2.0	30	9.0	21	3.0	48	6.0	41

PP																
N. Kenya PP	30	3.0	35	9.0	8	0.0	58	5.0	28	3.0	30	9.0	9	0.0	31	3.0	33
S. Kenya AP	4	0.1	13	1.0	8	0.3	11	0.4	5	1.0	12	5.0	7	1.0	9	2.0	10
S. Kenya PP	13	1.0	11	3.0	10	1.0	19	2.0	8	0.7	12	3.0	7	1.0	28	3.0	13
N. Tanzania AP	20	1.0	24	3.0	14	0.6	33	1.0	11	1.0	9	4.0	22	3.0	20	2.0	16
N. Tanzania PP	17	2.0	22	5.0	15	0.7	40	2.0	12	2.0	14	4.0	12	1.0	23	2.0	18
C. Tanzania AP	21	0.7	9	0.8	11	0.4	16	0.8	11	1.0	16	6.0	12	2.0	24	4.0	16
C./SW Uganda AP	0.0	0.0	6	0.7	0	0.0	42	3.0	0	0.0	9	2.0	0	0.0	31	3.0	9
EL Niño																	
S. Ethiopia PP	13	1.0	10	1.0	19	1.0	13	1.0	16	2.0	8	3.0	9	1.0	7	1.0	11
N. Kenya PP	37	3.0	41	9.0	37	2.0	48	4.0	47	5.0	44	14	19	1.0	37	4.0	41
S. Kenya AP	19	1.0	12	2.0	21	1.0	24	1.0	26	2.0	61	22	15	2.0	44	7.0	38
S. Kenya PP	25	1.0	38	9.0	29	3.0	56	7.0	21	1.0	22	6.0	20	2.0	56	6.0	34
N. Tanzania AP	11	0.4	4	0.4	2	0.1	10	0.4	15	2.0	2	0.7	1	0.1	4	0.6	4
N. Tanzania PP	6	0.5	6	1.0	3	0.2	11	0.7	8	1.0	5	2.0	5	0.6	13	1.0	7
C. Tanzania AP	16	0.5	11	1.0	21	1.0	40	2.0	17	2.0	20	7.0	13	2.0	28	4.0	20
C./SW Uganda AP	0	0.0	0	0.0	0	0.0	23	2.0	4	0.3	6	2.0	5	0.3	24	4.0	8

1. AP = agropastoral; PP= pure pastoral.
2. R/E = replacement ewes.
3. RFG = replacement female goats.

Southern Ethiopia

The mean small ruminant category ratio for S. Ethiopia was 1:3:1:1:1:6:2:2 for rams:ewes:replacement-ewes:lambs:bucks:does:replacement-female goats:kids, respectively. This ratio indicates that does constituted the largest single category in the small ruminant herds of S. Ethiopia. During both the drought and El Niño phases, does constituted the highest number of herd mortalities. During the drought, however, only 30% of does compared with

81% of replacement ewes died: thus, replacement ewes were the more vulnerable group. Replacement ewes were also the most vulnerable group during the El Niño phase.

Northern Kenya

The small ruminant category ratio for N. Kenya was 2:5:1:2:2:7:1:3 for rams:ewes:replacement-ewes:lambs:bucks:does:replacement female goats:kids, respectively. This ratio indicates that does and ewes constituted the two largest categories in the herds.

During both the drought and El Niño phases, does constituted the largest percentage of total herd mortalities. However, during both stress phases in N. Kenya, lambs were the most vulnerable category, with 58% and 48% of lambs succumbing in the drought and El Niño rains, respectively. Total herd mortality was higher for the El Niño rains phase than for the drought mainly due to the outbreak of CCPP.

Southern Kenya agropastoral areas

The small ruminant category ratio for S. Kenya agropastoral areas was 1:3:1:1:3:11:3:4 for rams:ewes:replacement-ewes:lambs:bucks:does:replacement- female goats:kids, respectively. This indicates that does were the dominant category of the herds. During both the drought and El Niño phases, does comprised the largest portion of total herd mortalities. However, ewes were slightly more vulnerable than does during the drought phase, with 13% of ewes and 12% of does dying (Table 26). Kids and does were the two most vulnerable categories during the El Niño phase, when 44% of the kids and 61% of does died.

Southern Kenya pure pastoral areas

The small ruminant category ratio for S. Kenya pure pastoral areas was 1:4:2:2:1:4:2:2 for rams:ewes:replacement-ewes:lambs:bucks:does:replacement female goats:kids, respectively. The ratio indicates that the ewes and does contributed the largest and equal numbers to the herd. During the drought phase, kids, ewes and does constituted the largest, equal percentages of total herd mortalities (3% of total for each). However, kids were the most vulnerable category and 28% of them died (Table 26). During the El Niño phase, ewes constituted the largest number of total herd mortalities; however, lambs and kids were far more vulnerable with 56% of each dying, compared with only 38% of the ewes.

Northern Tanzania agropastoral areas

The small ruminant category ratio for N. Tanzania agropastoral areas was 1:3:1:1:3: 10:4:3 for rams:ewes:replacement-ewes:lambs:bucks:does:replacement-female goats:kids, respectively. Does contributed most to total herd numbers. During the drought phase, the does constituted the largest number of mortalities (Table 26) but lambs were the most vulnerable category (33% of lambs died vs. 9% of does). During the El Niño phase, bucks constituted the largest proportion of total herd mortalities and the most vulnerable category with 15% of them dying.

Northern Tanzania pure pastoral areas

The small ruminant category ratio for N. Tanzania pure pastoral areas was 2:4:1:1:2: 5:1:1 for rams:ewes:replacement-ewes:lambs:bucks:does:replacement-female goats:kids, respectively. Does constituted the largest portion of the total herd. During the drought, ewes contributed the largest numbers to total herd mortality; however, lambs were the most vulnerable category, with 40% of lambs dying compared with only 22% of ewes (Table 26).

During the El Niño phase, does again constituted the largest portion of total herd mortality;

however, the most vulnerable category was the kids of which 13% died.

Central Tanzania

The small ruminant category ratio for C. Tanzania was 1:3:1:2:3:11:5:5 for rams:ewes: replacement-ewes:lambs:bucks:does:replacement-female goats:kids, respectively. Does constituted the largest category within the total herd. During both the drought and El Niño rains, goat mortalities were higher than those for sheep (Table 26). Does contributed the largest portion to total herd mortality in both stress periods.

However, during the drought, kids were the most vulnerable category and 24% of them died. In the El Niño phase, lambs were the most vulnerable category and 40% died compared with only 20% of does.

Central/south-western Uganda

The small ruminant category ratio for C./SW Uganda was 2:3:1:1:2:5:3:3 for rams: ewes:replacement-ewes:lambs:bucks:does:replacement-female goats:kids, respectively. Therefore, does contributed the largest portion as a single category to the total herd number.

There were low small ruminant numbers in this zone compared with other zones and mortality losses were minimal. Kids contributed the most to both the drought and El Niño total herd mortalities (Table 26). Lambs and kids were the most vulnerable categories during both the drought and El Niño phases.

In general, across zones, while does and ewes constituted the largest portion of the total herd mortalities, the most vulnerable small ruminant categories were kids and lambs.

2.4 Camel herd dynamics

Camel herd data were reported for S. Ethiopia and N. Kenya only. These neighbouring pure pastoral zones were the two most arid zones surveyed. Camels were valued both as beasts of burden and sources of food (milk and meat).

2.4.1 Camel herd size

The recorded mean camel herd sizes per household in the two zones are indicated in Table 27.

Table 27. *Mean number of camels per household in S. Ethiopia and N. Kenya across climatic phases.*

Zone	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	13	11	5	3	7
N. Kenya	6	5	4	4	4

In both zones, throughout the drought, minor rains and El Niño phases, number of camels per herd decreased from pre-drought numbers. The numbers decreased sharply in S. Ethiopia, especially between the drought phase and the minor rains phase. Herd size in S. Ethiopia showed some recovery during the La Niña phase but similar indications of recovery were not seen in N. Kenya.

2.4.2 Camel birth rates

Birth rate was the number of births expressed as a percentage of the number of female camels. Camel birth rates are presented in Table 28. The birthing pattern was similar in S. Ethiopia and N. Kenya, with birth rates increasing from pre-drought levels to a peak during the El Niño phase. However, the birth rates were much higher in N. Kenya than in S. Ethiopia.

Table 28. *Mean camel birth rates (%) in S. Ethiopia and N. Kenya across climatic phases.*

Zone	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	4.6	9.6	22.8	27.3	19.6
N. Kenya	27.7	45.1	50.5	56.2	50.9

2.4.3 Camel sales, purchase and slaughter rates

Camel sales, purchase and slaughter rates were calculated as the percentage of a household's camels that were sold, purchased or slaughtered, respectively, during a given climatic phase. Camel sales, purchase and slaughter rates are presented in Table 29. The camel sales patterns for the two zones were different, with S. Ethiopia recording peak sales during the drought (7.2%) and N. Kenya recording peak sales during the minor rains period (2.9%). However, in both zones camel sales rates were low and sales were much lower in N. Kenya than in S. Ethiopia.

Table 29. *Mean camel sale, purchase and slaughter rates (%) per household in S. Ethiopia and N. Kenya across climatic phases.*

Zone and independent variable	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia					
Sales	3.7	7.2	6.0	6.3	5.1
Purchases	0.2	0.3	0.0	0.0	3.6
Slaughter	1.8	2.6	4.7	3.3	3.1
N. Kenya					
Sales	1.6	2.0	2.9	0.2	0.8
Purchases	0.6	0.2	0.0	0.0	0.0
Slaughter	0.9	1.6	0.2	1.2	1.9

Camel purchase rates were even lower than sales rates in the two zones. Very low sales rates were recorded for the pre-drought period, even lower sales rates during the drought and no sales in either zone during the minor rains or El Niño rains phases. Households in S. Ethiopia purchased over 3% of their herd of camels in the La Niña dry phase.

Camel slaughter rates for both zones were higher than purchase rates but lower than sales rates. More camels were slaughtered in S. Ethiopia than in N. Kenya. In N. Kenya peak slaughtering was reported in the drought phase; in S. Ethiopia, peak slaughtering was reported in the minor rains phase. Pastoralists indicated that they preferred to sell, rather than slaughter, camels, as it was difficult to preserve the large carcasses of camels. The pastoralist preferred to purchase small ruminants for slaughter.

2.4.4 Camel disease incidence

Incidences of camel diseases (epidemic/infectious and parasitic/viral) reported by pastoralists are presented in Table 30. Over half of the pastoralists in S. Ethiopia.

Table 30. *Respondents (%) reporting camel disease incidence in S. Ethiopia and N. Kenya during the drought and the El Niño phases.*

Climatic phase	Zone	Epidemic/ infectious	Parasitic/viral
Drought			
	S. Ethiopia	55	58
	N. Kenya	25	12
El Niño			
	S. Ethiopia	15	12
	N. Kenya	27	27

Incidences of camel diseases reported in N. Kenya were lower than those reported in S. Ethiopia during the drought. In N. Kenya during the El Niño period, incidence of parasitic/viral diseases was similar to that for epidemic infections. However, pastoralists reported that parasitic/viral disease incidence doubled from 12% in the drought to 27% during the El Niño rains.

2.4.5 Camel mortality

Mortality was calculated as the number of deaths that occurred in a given phase expressed as a percentage of herd size during the previous phase. Mortalities during the drought and El Niño rains phases are presented for each camel category, as a percentage of that category and as a percentage of the whole herd (Table 31). In S. Ethiopia, camel mortality was greater during the drought phase than the El Niño phase; the opposite was true for N. Kenya. In both S. Ethiopia and N. Kenya, female camels constituted the largest proportion of mortalities. However, young camels were the most vulnerable category in both zones during the drought; over 30% of young camels died in each zone.

Table 31. *Mean camel mortalities in S. Ethiopia and N. Kenya by category as a percentage of each category and as a percentage of the total herd.*

Climatic phase and zone	Male camel mortality		Female camel mortality		Replacement female mortality		Young camel mortality		Total herd mortality (%)
	% of MC[1]	% of herd	% of FC[2]	% of herd	% of RFC[3]	% of herd	% of YC[4]	% of herd	
Drought									
S. Ethiopia	19	3	21	11	20	4	34	5	23
N. Kenya	18	4	13	8	25	1	31	5	18
El Niño									
S. Ethiopia	11	1	7	3	4	1	15	3	8
N. Kenya	34	8	24	12	15	2	18	3	25

1. MC = male camels; 2. FC= female camels; 3. RFC = replacement female camels; 4. YC= young camels.

During the El Niño phase, as during the drought, female camels constituted the largest proportion of mortalities. However, in S. Ethiopia, young camels were the most vulnerable category, with 15% dying compared with 7% of female camels. In N. Kenya, male camels were the most vulnerable category, with 34% dying compared with 24% of the female camels.

2.5 Equine herd dynamics

Equines (donkeys and horses) like camels, were only reported for S. Ethiopia and N. Kenya, both of which were pure pastoral areas.

2.5.1 Equine herd size

Fewer equines than camels were kept by each household, with households in N. Kenya owning slightly more equines than households in S. Ethiopia (Table 32).

Table 32. *Mean equine herd size per household in S. Ethiopia and N. Kenya over the climatic phases surveyed.*

Zone	Number of households	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	85.0	1.2	1.1	0.5	0.4	0.4
N. Kenya	100.0	1.7	1.5	1.4	1.3	1.2

In both zones, equine herd size decreased from pre-drought levels through out the phases to a low in the El Niño rains and La Niña dry phases in S. Ethiopia and N. Kenya, respectively.

2.5.2 Equine sales, purchase and slaughter rates

Equine sales, purchase and slaughter rates were calculated as the percentage of a household's equines that were sold, purchased or slaughtered, respectively, during a given climatic phase. Equine sales were low in S. Ethiopia and even lower in N. Kenya (Table 33). In S. Ethiopia, peak sales were recorded during the El Niño phase, while peak sales in N. Kenya were recorded in the drought phase. In both zones, purchase rates for equines tended to be lower than sales; fewer equines were purchased in N. Kenya than in S. Ethiopia. In both zones, peak purchasing of equines occurred in the pre-drought phase.

Table 33. *Mean equine sales, purchases and slaughter rates (%) in S. Ethiopia and N. Kenya over the climatic phases surveyed.*

Zone and independent variable	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia					
Sales	0.9	9.7	4.3	16.7	2.3
Purchases	6.5	1.8	0.0	0.0	0.0
Slaughter	0.0	0.0	0.0	0.0	0.0
N. Kenya					
Sales	0.0	2.8	0.8	0.8	0.9
Purchases	1.2	0.0	0.8	0.0	0.0
Slaughter	0.6	0.0	0.0	0.0	0.0

Very minimal slaughter of equines was reported: none in S. Ethiopia, and less than 1% in N. Kenya. This reflects the value of equine species, especially donkeys, for domestic transport and in particular for the task of hauling water, a duty under the female domain.

Distances to consumable water sources increased with climatic stress, thus, increasing the requirement for equine domestic transport. Horses were valued as marks of prestige and for ceremonial occasions.

2.5.3 Equine disease incidence

Disease incidence reported for equines was much lower than that for camels. During the drought phase, there was a higher incidence of disease among equines in S. Ethiopia than in N. Kenya (Table 34). The reverse was true for the El Niño period where there was a higher disease incidence among N. Kenya equines. In S. Ethiopia, parasitic and viral diseases were the most commonly reported diseases during both the drought and El Niño phases. In N. Kenya, incidence of parasitic and viral diseases was similar to that of epidemic/infectious diseases within each climatic phase.

Table 34. *Respondents (%) reporting incidence of diseases (epidemic/ infectious and parasitic/viral) among equines in S. Ethiopia and N. Kenya during the drought and El Niño phases.*

Climatic phase	Zone	Epidemic/infectious	Parasitic/viral
Drought			
	S. Ethiopia	22.4	27.1
	N. Kenya	7.0	6.0
El Niño rains			
	S. Ethiopia	2.4	5.9
	N. Kenya	16.0	16.0

2.6 Human welfare

Human welfare is affected by climatically stressful periods and this in turn impacts on livestock welfare. In this study, human welfare was examined both in relation to diet (food groups consumed and frequency of consumption over the climatic phases surveyed) and in terms of intensification of diseases during the climatically stressful phases.

2.6.1 Pastoral diet across climatic phases

Composition of pastoralists' diets was investigated by examining the types of foods which were consumed frequently. The five food types examined were: cereals/grains, milk and milk products, meat, vegetables and fruits. The proportions of respondents who reported frequent consumption of the food types across the climatic phases are indicated in Table 35. In the agropastoral areas, the major food types were cereals/grains, milk and milk products and vegetables. There was a very strong dependence on cereals/grains, with at least 80% of the respondents frequently consuming cereal/grain products throughout the climatic phases. The pure pastoralists' diet was constituted mostly of cereals/grains, milk and milk products. Meat was consumed by both pastoral groups; however, more agropastoralists than pure pastoralists reported frequent consumption of meat. The quantities of each food type consumed were, however, not recorded. Percentage of pure pastoralists consuming meat frequently was higher during the drought than during the other climatic phases. Throughout all climatic phases, agropastoralists ate fruit more frequently than pure pastoralists indicating that the agropastoral diet was more balanced than the pure pastoral diet.

Table 35. *Respondents (%) who reported frequent consumption of the different food types, in the different zones, over the climatic phases surveyed.*

Zone and pastoral category[1]	Food type	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry	Overallmean
S. Ethiopia PP							
	Cereals/grains	58	39	13	12	29	30.0
	Milk/milk products	84	13	21	20	41	36.0
	Meat	7	34	4	2	2	10.0
	Vegetables	0	0	0	1	0	0.2
	Fruits	0	0	0	0	0	0.0
N. Kenya PP							
	Cereals/grains	40	63	47	49	50	50.0
	Milk/milk products	33	9	37	65	55	40.0
	Meat	20	23	10	25	19	19.0
	Vegetables	11	4	16	11	19	12.0
	Fruits	12	10	8	5	11	9.0
S. Kenya AP							
	Cereals/grains	100	97	97	100	97	98.0
	Milk/milk products	66	38	62	97	97	72.0
	Meat	41	41	48	48	45	45.0
	Vegetables	48	41	76	93	86	69.0
	Fruits	31	28	48	52	52	42.0
S. Kenya PP							
	Cereals/grains	76	91	76	73	74	78.0
	Milk/milk products	52	14	48	77	76	53.0
	Meat	19	13	14	16	20	16.0
	Vegetables	34	42	43	44	50	43.0
	Fruits	11	13	11	14	15	13.0
N. Tanzania AP							
	Cereals/grains	97	88	85	91	85	89.0
	Milk/milk products	41	9	62	77	74	53.0
	Meat	21	18	15	15	21	8.0
	Vegetables	27	21	41	74	65	46.0
	Fruits	6	9	62	24	24	25.0
N. Tanzania PP							
	Cereals/grains	82	75	64	62	77	72.0
	Milk/milk products	53	23	53	87	82	60.0
	Meat	20	16	18	28	31	23.0
	Vegetables	10	3	12	28	25	16.0
	Fruits	5	3	3	3	10	5.0

C. Tanzania AP							
	Cereals/grains	94	63	61	61	83	72.0
	Milk/milk products	76	16	52	72	94	62.0
	Meat	32	32	29	25	56	35.0
	Vegetables	74	29	69	69	85	65.0
	Fruits	25	15	16	17	27	20.0
NW Tanzania AP							
	Cereals/grains	96	94	95	92	94	94.0
	Milk/milk products	23	4	34	69	54	37.0
	Meat	8	8	5	10	10	8.0
	Vegetables	48	33	70	83	69	61.0
	Fruits	5	4	12	8	12	8.0
C/SW Uganda AP							
	Cereals/grains	73	86	60	59	52	66.0
	Milk/milk products	93	62	95	93	92	87.0
	Meat	30	41	36	34	33	35.0
	Vegetables	22	19	36	34	36	29.0
	Fruits	8	5	7	7	8	7.0
Means: AP							
	Cereals/grains	92	86	80	81	82	84.0
	Milk/milk products	60	26	61	82	82	62.0
	Meat	26	28	27	26	33	28.0
	Vegetables	44	29	58	71	68	54.0
	Fruits	15	12	29	22	25	20.0
Means: PP							
	Cereals/grains	64	67	50	49	58	58.0
	Milk/milk products	56	15	40	62	64	47.0
	Meat	17	22	12	18	18	17.0
	Vegetables	14	12	18	21	24	18.0
	Fruits	7	7	6	6	9	7.0

1. AP = agropastoral; PP = pure pastoral.

Drought affected the diets of both agro- and pure pastoralists. Milk consumption was drastically affected, with frequency of consumption decreasing sharply. The most frequent milk consumption was recorded during the El Niño rains and La Niña dry phases. Vegetable consumption by agropastoralists was similarly affected by drought, with frequency of consumption decreasing markedly with the drought and recovering with the onset of the rains.

From the results, it is apparent that the food types that were most sensitive to climatic stress were milk and milk products and vegetables. The majority of households consumed cereals and grains frequently throughout the climatic phases. Compared with cereals and grains, meat was consumed by fewer households on a frequent basis. Fruit was consumed frequently by only a small proportion of households.

2.6.2. Incidence of human disease across climatic phases

Human diseases surveyed were categorised as: (i) epidemic/infectious diseases, such as tuberculosis, typhoid fever, cholera and human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS); (ii) parasitic/viral diseases, such as malaria, trypanosomiasis, Rift Valley fever and gastro-intestinal parasites; and (iii) other conditions, such as malnutrition, and eye and skin problems. Human diseases were reported across all climatic phases. Recorded incidence of illnesses among the households surveyed during the drought and El Niño phases is indicated in Table 36. Generally there was a higher incidence of illnesses in the El Niño phase than in the drought phase. Intensification of human illnesses and/or deaths during the drought and El Niño phases is also presented in Table 36.

Table 36. *Percentage of respondents who reported an increase in human illnesses and/or deaths during the drought and the El Niño rains in the surveyed zones.*

Climatic phase	Zone	Pastoral category[1]	Incidence of any illness	Epidemic/ infectious		Parasitic/viral	
				% incidence	% death	% incidence	% death
Drought							
	S. Ethiopia	PP	59	47	8	49	15
	N. Kenya	PP	48	38	5	42	3
	S. Kenya	AP	36	36	0	36	0
	S. Kenya	PP	13	5	2	12	1
	N. Tanzania	AP	41	15	0	32	3
	N. Tanzania	PP	57	28	2	48	5
	C. Tanzania	AP	10	13	3	37	1
	NW Tanzania	AP	20	7	2	16	5
	C./SW Uganda	AP	52	59	1	66	3
	Means						
		AP	32	26	1	38	2
		PP	44	30	4	37	6
El Niño rains							
	S. Ethiopia	PP	11	4	1	6	0
	N. Kenya	PP	76	50	5	57	4
	S. Kenya	AP	42	6	3	39	3
	S. Kenya	PP	67	38	7	59	2
	N. Tanzania	AP	79	29	0	68	0
	N. Tanzania	PP	66	30	0	57	0
	C. Tanzania	AP	83	28	2	68	3
	NW Tanzania	AP	26	8	1	21	3
	C./SW Uganda	AP	59	52	6	66	14
	Means:						
		AP	55	25	2	52	5

		PP	58	31	4	45	2

1. AP = agropastoral; PP = pure pastoral.

During the drought phase, parasitic/viral diseases were predominant across all zones. The most common disease was malaria, which intensified during the El Niño rains. The occurrence of gastro-intestinal parasites was common, a possible reflection of the poor quality of available drinking water. Across zones, with the exception of S. Ethiopia, parasitic/viral diseases intensified during the El Niño rains.

Epidemic diseases intensified with the El Niño rains only in N. Kenya, N. Tanzania and C. Tanzania. In general, there was higher disease incidence during the El Niño rains than during the drought. Incidence of disease was similar in the agro- and pure pastoral zones but a slightly higher percentage of deaths tended to occur in the pure pastoral zones during the drought. Figures 21 to 29 present the occurrence of human diseases (epidemic infectious and parasitic/viral) during the pre-drought to La Niña dry phases, individually for each zone.

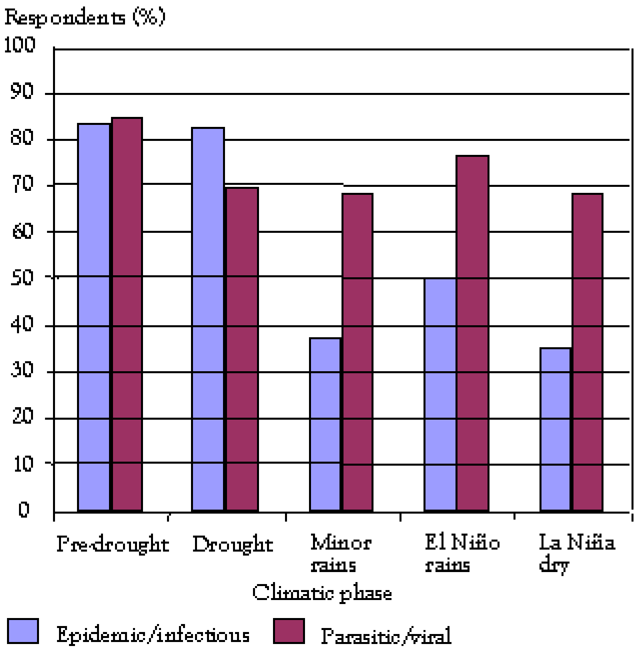

Figure 21. *Percentages of pastoralists in S. Ethiopia who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

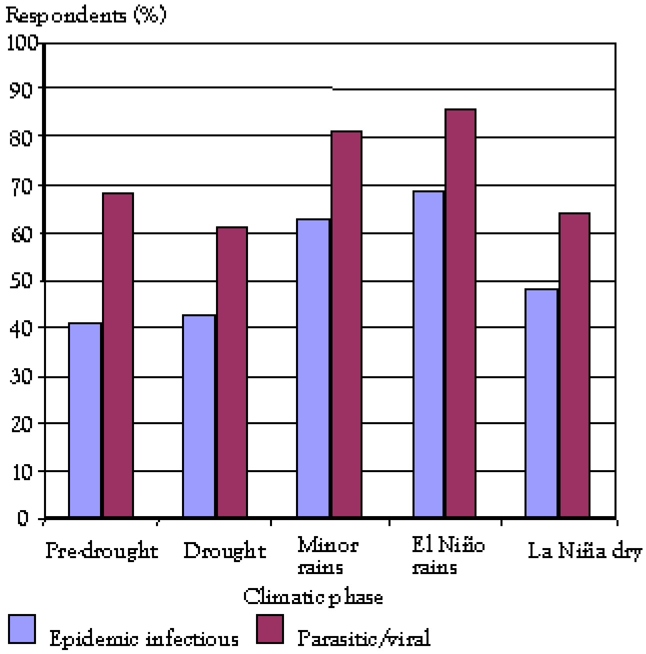

Figure 22. *Percentages of pastoralists in N. Kenya who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

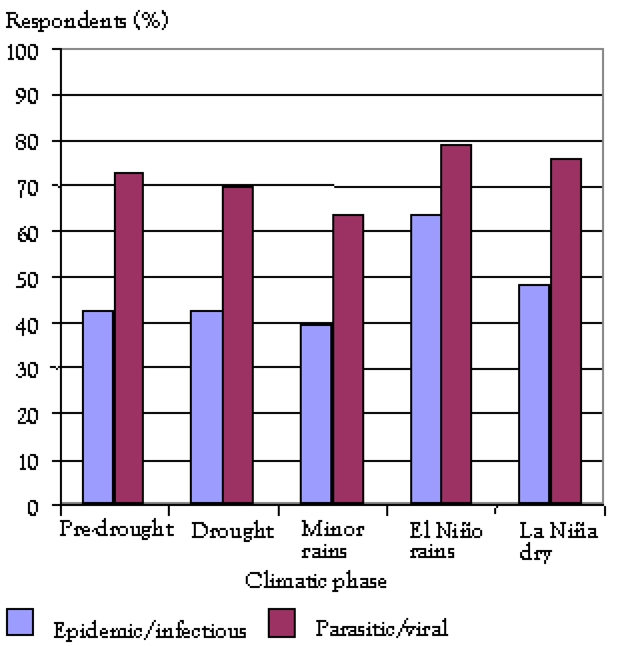

Figure 23. *Percentages of pastoralists in S. Kenya agropastoral areas who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

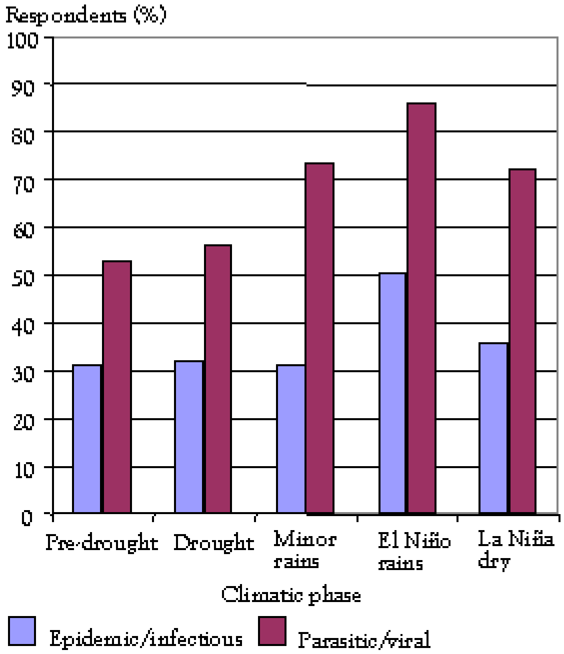

Figure 24. *Percentages of pastoralists in S. Kenya pure pastoral areas who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

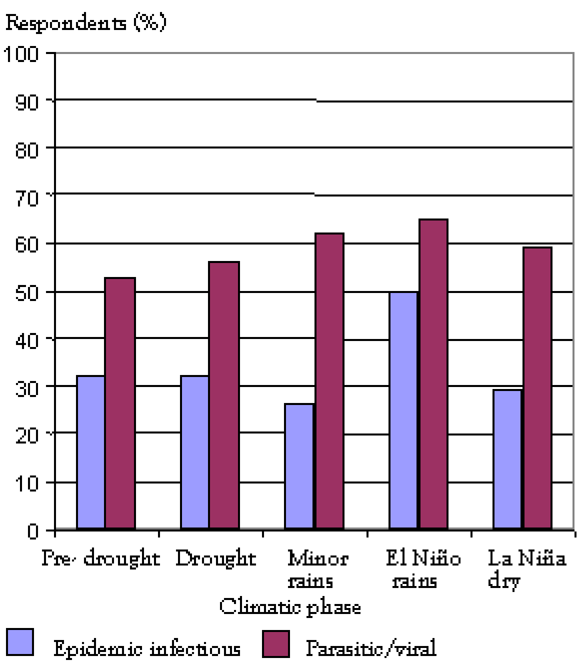

Figure 25. *Percentages of pastoralists in N. Tanzania agropastoral areas who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

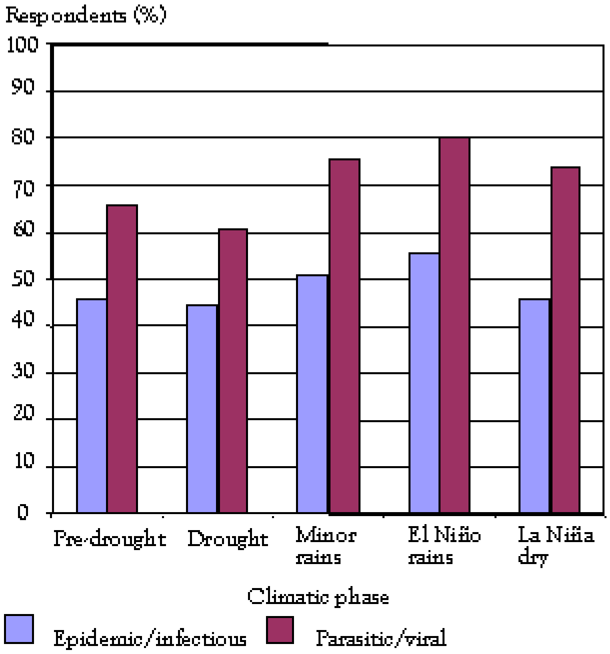

Figure 26. *Percentages of pastoralists in N. Tanzania pure pastoral areas who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

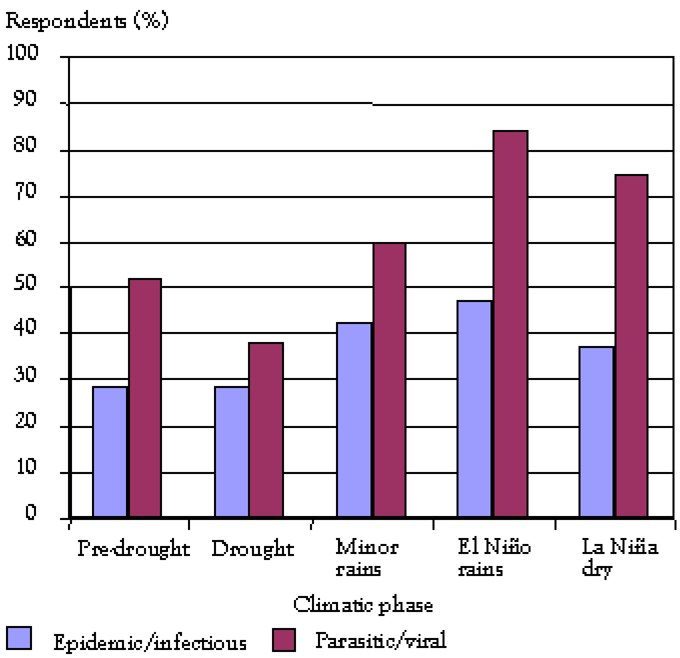

Figure 27. *Percentages of pastoralists in C. Tanzania who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

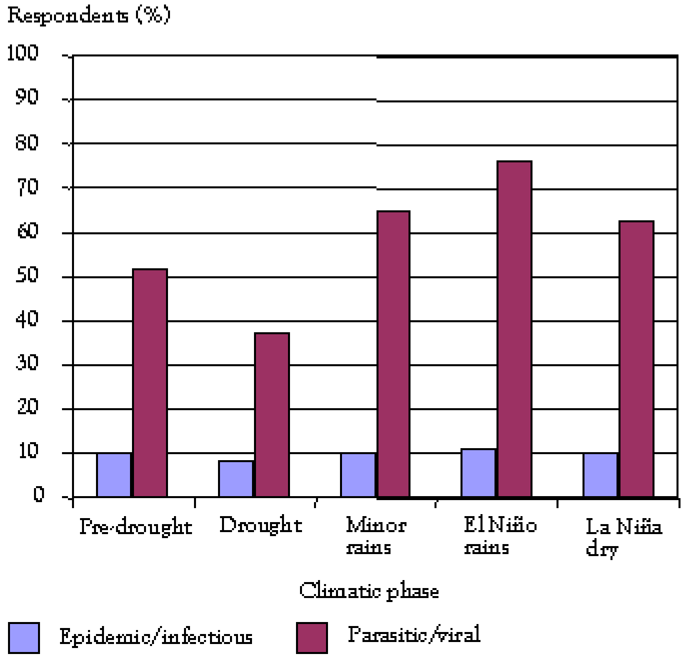

Figure 28. *Percentages of pastoralists in NW Tanzania who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

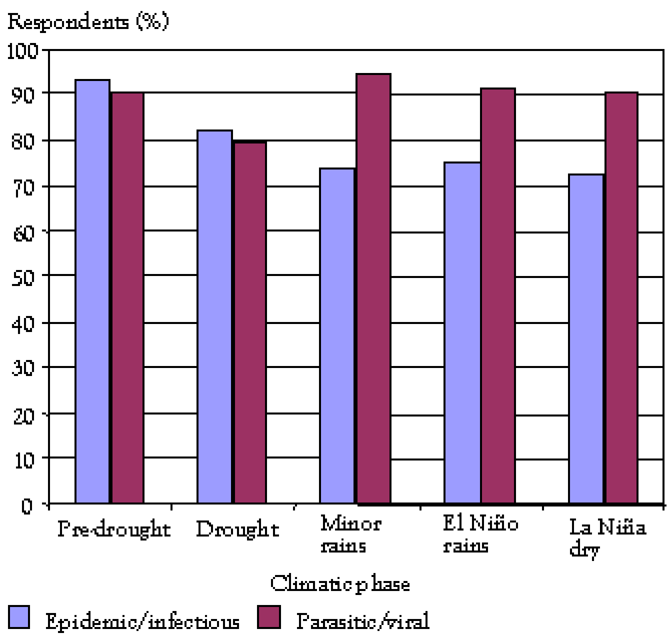

Figure 29. *Percentages of pastoralists in C./SW Uganda who reported occurrence of human disease (epidemic/infectious and parasitic/viral) across climatic phases.*

2.6.3 Preventative measures and treatment of illnesses

Strategies utilised by pastoralists to prevent disease included: (i) vaccination-immunisation; (ii) ethno-therapy (use of herbs and other traditional remedies); (iii) hygienic measures (e.g. boiling water/milk, washing of hands/clothing, use of latrines and destruction or disposal of dead animal carcasses instead of consuming them); (iv) migration from infected areas; and (v) eradication of vectors such as mosquitoes by use of insecticides, use of mosquito coils, clearing of brush and tall grasses around homesteads, and drainage of stagnant waterholes. The most common preventative measure employed was the use and enforcement of hygienic measures. Illnesses were treated by ethno-therapeutic methods (e.g. local medicines made from herbs, roots and other concoctions) or at clinics and hospitals. Most pastoralists used ethno-therapeutic methods.

3 Pastoral coping mechanisms, their efficacy and external assistance provided to the pastoralists

3.1 Minimising risk and managing loss

Coping mechanisms are responses of an individual, group or society to challenging situations. The coping mechanisms lie within the framework of the individual's/ group's/society's risk aversion or tolerance level, i.e. are institutes to minimise risk or to manage loss. While some coping mechanisms may be brought into play by a stress factor, others may be an intensification of an already in-built strategy. Coping mechanisms identified in this survey are broadly grouped as either managerial strategies or community strategies. Managerial strategies include: movement and migration; various aspects of herd management; supplementation of grazing with other feeds; changes in herding labour with intensification of stress; management of diseases (both human and livestock); and changes in human diet. Community strategies include: sharing, loaning and giving of livestock as gifts; and institution of legal restrictions, necessary because the rangelands resources (forage and water) are shared by parties with conflicting and varied interests.

3.2 Movement and migration

Mobility is an inherent strategy of pastoralists to optimise production of a heterogeneous landscape under a precarious climate. The search for water (for human and livestock consumption) and forage, triggered mobility and migration; these strategies were most intensified by drought.

Distance trekked to livestock water sources was almost tripled during the drought, from an average (across zones) of 5.9 km pre-drought to 15.8 km during the drought; pure pastoralists trekked greater distances than agropastoralists. Distances to grazing sites also increased, from an average (across zones) of 5.5 km pre-drought to 20.4 km during the drought, with pure pastoralists trekking greater distances than agropastoralists. Emergency water sources and grazing sites were used. Interestingly, these were not necessarily further from the homestead than normal water sources and primary grazing sites. For example, in some areas, swamps/marshlands that were closer to the homesteads than the primary grazing sources were used in emergency times. Pastoralists avoided these areas as much as possible during other times because they were disease-infested areas. In general, distances trekked to water were greater than distances to grazing sites. Distances to emergency water sources and grazing sites were greatest for the most arid zones of S. Ethiopia and N. Kenya.

Pastoralists divided herds into core and satellite herds; the satellite herds being constituted of hardy males and dry females of the generally larger livestock species, such as cattle and camels. Small ruminants and breeding stock (core herds) were left at the homesteads where women and children cared for them. Generally, in drought, the main homestead remained intact with family members (especially women, children and the elderly) in occupancy while herders moved the livestock. Sometimes, one or two household members migrated to find work in towns or villages. Children were also sent to boarding schools to ensure that they received adequate food and shelter.

During the El Niño rains, the major causes of movement were destruction of the homestead by floods or excessive rain, and the need to search for food, grazing and water. As the rains continued, incidence of diseases (e.g. malaria) increased and in highly susceptible areas, forced people to evacuate their homesteads.

3.3 Herd management strategies

Pastoralists used strategies related to herd structure as well as other tactics to manage the climatic stresses. Herd management strategies included:

- Maintenance of female dominated herds: Pastoralists in all zones maintained female dominated herds, with C./SW Uganda having the highest number of cows to bulls, a ratio of 10:1. Coppock (1994) cited studies which noted that a female dominated herd structure was used to offset long calving intervals and thus stabilise milk production.
- Herd diversification: The Simpson index (SI) of species diversity, was used to calculate diversity of the herds. Accordingly, N. Kenya and S. Ethiopia had the most diverse herds with post-stress SI values of 0.56 and 0.68, respectively, while C./SW Uganda and NW Tanzania had the least diverse herds, with pre-stress SI values of 0.99 for both zones. N. Kenya and S. Ethiopia are the most arid zones while C./SW Uganda and NW Tanzania are the least arid. Herd diversity, therefore, appears to be a strategy that is particularly useful in arid areas, where advantage can be taken of the various adaptations of different livestock species. Moreover, different livestock species are valued for differing reasons. For example, equines were highly valued as a form of transport whereas small ruminants were highly valued as a convenient source of income and food (milk and meat).
- Herd size: Accumulation of livestock was a common strategy across zones, with most purchases of stock occurring in the pre-drought and La Niña (recovery) phases.
- Partitioning of livestock into core and satellite herds: Mature and hardy livestock were included in satellite herds, which trekked long distances in order to conserve the nearer sources of water and forage for the core herd (young and breeding stock). Women and children were left at homesteads to take care of the core herd.
- Uncontrolled breeding: Uncontrolled breeding resulted in birth of livestock during each of the climatic phases. This strategy offsets the risks due to vagaries of climate and allows pastoralists to take advantage of favourable periods, if and when they occur.

3.4 Livestock supplementation

The practice of supplementation of livestock grazing with other feeds was examined. The four most commonly used supplement types were shrub/fodder tree material, crop residues, forage and by-products. Data recorded for supplementation of cattle and small ruminants are presented in Tables 37 and 38, respectively.

Table 37. *Percentages of households per zone who reported supplementing cattle grazing*

during each of the climatic phases.

Zone	Pastoral category[1]	Supplement type	Pre-drought	Drought	Minor rains	El Niño rains	LaNiña dry
S. Ethiopia	PP	Shrub/tree fodder	15.3	23.6	3.5	4.7	0.0
		Crop residues	14.1	11.7	4.7	3.5	0.0
		Forage	2.4	7.0	0.0	0.0	0.0
		By-products	1.2	0.0	0.0	0.0	0.0
N. Kenya	PP	Shrub/tree fodder	7.0	7.0	4.0	3.0	4.0
		Crop residues	3.0	2.0	2.0	2.0	1.0
		Forage	0.0	1.0	0.0	1.0	1.0
		By-products	2.0	2.0	2.0	1.0	1.0
S. Kenya	AP	Shrub/tree fodder	0.0	0.0	0.0	0.0	0.0
		Crop residues	33.3	6.1	0.0	0.0	3.0
		Forage	3.0	9.1	3.0	3.0	3.0
		By-products	3.0	3.0	3.0	3.0	3.0
S. Kenya	PP	Shrub/tree fodder	0.0	6.9	0.0	0.0	0.0
		Crop residues	9.2	12.6	6.9	4.6	5.7
		Forage	2.3	8.0	3.4	2.3	2.3
		By-products	9.2	19.5	13.8	6.9	8.0
N. Tanzania	AP	Shrub/tree fodder	23.5	8.8	17.6	8.8	5.9
		Crop residues	55.9	47.1	20.6	14.7	23.5
		Forage	23.5	17.6	23.5	23.5	23.5
		By-products	2.9	0.0	0.0	2.9	8.8
N. Tanzania	PP	Shrub/tree fodder	18.0	11.5	13.1	4.9	9.8
		Crop residues	32.8	27.9	8.2	3.3	16.4
		Forage	19.7	24.6	16.4	13.1	13.1
		By-products	4.9	6.6	4.9	0.0	4.9
C. Tanzania	AP	Shrub/tree fodder	3.4	5.7	6.9	1.1	1.1
		Crop residues	17.2	31.0	11.5	1.1	6.9
		Forage	5.7	6.8	4.6	2.3	0.0
Drought	Minor rains	El Niño rains	La Niña dry				

		By-products	12.6	19.5	8.0	2.3	8.0
NW Tanzania	AP	Shrub/tree fodder	12.0	11.0	7.0	6.0	6.0
		Crop residues	19.0	14.0	4.0	3.0	5.0
		Forage	3.0	4.0	1.0	0.0	0.0
		By-products	2.0	2.0	1.0	1.0	1.0
C./SW Uganda	AP	Shrub/tree fodder	1.4	0.0	0.0	0.0	1.1
		Crop residues	2.7	2.7	1.4	1.4	2.7
		Forage	0.0	0.0	0.0	0.0	0.0
		By-products	0.0	0.0	0.0	0.0	0.0
Means							
	AP PP	Shrub/tree fodder	8.1	5.1	6.3	3.2	2.8
		Crop residues	25.6	20.2	7.5	4	8.2
		Forage	7.0	7.5	6.4	5.8	5.3
		By-products	4.1	4.9	2.4	1.8	4.2
		Shrub/tree fodder	10.1	12.3	5.2	3.2	3.5
		Crop residues	14.8	13.6	5.5	3.4	5.8
		Forage	6.1	10.2	5.0	4.1	4.1
		By-products	4.3	7.0	5.2	2.0	3.5

1. AP = agropastoral; PP = pure pastoral.

Table 38. *Percentages of households per zone who reported supplementing small ruminants' grazing during each of the climatic phases.*

Zone	Pastoral category[1]	Supplement type	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
S. Ethiopia	PP	Shrub/tree fodder	12.9	27.1	4.7	3.5	0.0
		Crop residues	8.2	4.7	3.5	2.4	0.0
		Forage	4.7	2.4	0.0	0.0	0.0
		By-products	0.0	0.0	0.0	0.0	0.0
N. Kenya	PP	Shrub/tree fodder	11.0	16.0	13.0	7.0	8.0
		Crop residues	3.0	9.0	6.0	2.0	1.0
		Forage	1.0	2.0	3.0	0.0	0.0
		By-products	3.0	5.0	4.0	1.0	1.0
S. Kenya	AP	Shrub/tree fodder	3.0	6.1	3.0	3.0	3.0

		Crop residues	30.3	3.0	3.0	3.0	6.1
		Forage	0.0	0.0	0.0	0.0	0.0
		By-products	0.0	0.0	0.0	0.0	0.0
S. Kenya	PP	Shrub/tree fodder	9.2	18.4	10.3	9.2	10.3
		Crop residues	5.7	4.6	4.6	4.6	4.6
		Forage	1.1	2.3	0.0	0.0	0.0
		By-products	0.0	3.4	2.3	0.0	0.0
N. Tanzania	AP	Shrub/tree fodder	41.2	32.4	38.2	24.0	26.5
		Crop residues	47.1	35.3	8.8	5.9	17.6
		Forage	11.8	14.7	11.8	5.9	8.8
		By-products	8.8	2.9	2.9	0.0	8.8
Drought	Minor rains	El Niño rains	La Niña dry				
N. Tanzania	PP	Shrub/tree fodder	31.1	24.6	21.3	12.0	18.0
		Crop residues	27.9	24.6	13.1	4.9	14.8
		Forage	19.7	24.6	14.8	15.0	16.4
		By-products	6.6	8.2	3.3	1.6	6.6
C. Tanzania	AP	Shrub/tree fodder	1.1	4.6	4.6	0.0	0.0
		Crop residues	4.6	11.5	2.3	2.3	2.3
		Forage	5.7	6.8	4.6	2.3	0.0
		By-products	2.3	5.7	3.4	1.1	3.4
NW Tanzania	AP	Shrub/tree fodder	6.0	5.0	3.0	4.0	5.0
		Crop residues	4.0	4.0	2.0	2.0	4.0
		Forage	1.0	1.0	0.0	0.0	0.0
		By-products	0.0	0.0	0.0	0.0	1.0
C./SW Uganda	AP	Shrub/tree fodder	0.0	0.0	0.0	0.0	0.0
		Crop residues	1.4	1.4	1.4	1.4	1.4
		Forage	0.0	0.0	0.0	0.0	0.0
		By-products	0.0	0.0	0.0	0.0	0.0
Means							
	AP	Shrub/tree fodder	10.3	9.6	9.8	6.1	6.9
		Crop residues	17.5	11.0	3.5	2.9	6.3
		Forage	3.7	4.5	3.3	1.6	1.8

		By-products	2.2	1.7	1.3	0.2	2.6
	PP	Shrub/tree fodder	16.1	21.5	12.3	7.8	9.1
		Crop residues	11.2	10.7	6.8	3.5	5.1
		Forage	6.6	7.8	4.5	3.7	4.1
		By-products	2.4	4.2	2.4	0.7	1.9

1. AP = agropastoral; PP = pure pastoral.

3.4.1 Cattle supplementation

Cattle’s grazing was supplemented in both the pure and agropastoral areas, with the highest number of households providing supplements during the drought and pre- drought periods (Plate 5 and Table 37). Supplementation of cattle was least during the El Niño phase. More agropastoralists than pure pastoralists provided supplements. The dominant supplement in the agropastoral areas was crop residues. Crop residues and shrub/tree fodder were utilised by similar proportions of the pure pastoral households surveyed.

Plate 5. *Crop residues used for supplementation in agropastoral areas*

N. Tanzania agro- and pure pastoral areas, and the C. Tanzania zone reported the greatest proportions of households supplementing cattle and C./SW Uganda the least.

3.4.2 Small ruminant supplementation

The percentage of households whom supplemented small ruminants’ grazing in each zone with the various types of supplements is indicated in Table 38.

Data indicate that small ruminant supplementation was similar to that for cattle, with most households indicating that they provided supplements during the pre-drought and drought phases. Supplementation was lowest during the El Niño phase. In both the agro- and pure pastoral areas, crop residues and shrub/tree fodder were the major supplements utilised for small ruminants.

In general, slightly more households supplemented small ruminants than supplemented cattle. As for cattle, N. Tanzania agro- and pure pastoral areas reported the greatest proportions of households supplementing small ruminants and C./SW Uganda the least.

3.5 Sharing, loan and gift arrangements

From the data recorded during the study (Figure 30), it appears that loaning, sharing and gift giving form part of a continuum that crosses all climatic phases. These arrangements, which include dowries and traditional ceremonial gifts, are an integral part of the communal way of life for pastoralists. Results indicate that sharing of assets intensified during drought in most zones.

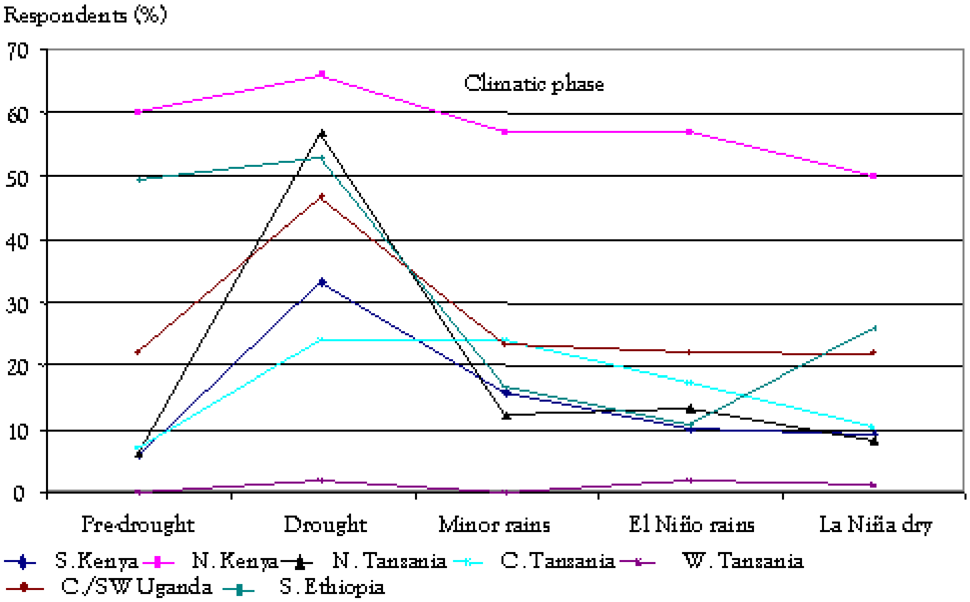

Figure 30. *Percentage of pastoralists per zone who reported sharing assets during each of the climatic phases surveyed.*

Proportions of respondents loaning livestock for various reasons are presented in Table 39. In all zones, the most common reason given for loaning livestock was as a source of milk for family consumption. Loaning for meat (to cover shortages) was the third overall reason for livestock loaning but it was of greater importance in the more arid zones dominated by pure pastoralists than in other zones. Loaning was more important during the drought phase than in any of the other climatic phases.

Table 39. *Percentage of respondents that loaned livestock for milk, herd disposal, meat, herd establishment and herd dispersal during drought (D) and over all climatic phases (M = mean value) across the zones surveyed.*

Zone	Pastoral category[1]	Milk		Disposal		Meat		Establishment		Dispersal	
		D	M	D	M	D	M	D	M	D	M
S. Ethiopia	PP	23.5	20.5	8.2	5.2	16.5	7.5	12.9	8.9	3.5	2.4
N. Kenya	PP	43.0	30.8	14.0	13.4	22.0	13.4	8.0	11.8	16.0	9.2
S. Kenya	AP	9.1	15.4	3.0	3.0	0.0	0.0	3.0	0.0	12.1	2.2
S. Kenya	PP	4.6	8.0	3.4	4.0	0.0	0.0	4.6	5.2	3.4	6.3
N.	AP	20.6	15.4	8.8	5.9	2.9	2.2	2.9	5.9	11.8	3.6

Tanzania											
N. Tanzania	PP	26.2	19.7	1.6	1.6	8.2	4.9	6.6	5.0	3.3	1.2
C. Tanzania	AP	20.7	23.0	3.4	1.8	2.3	2.3	6.9	7.3	12.6	5.5
NW Tanzania	AP	10.0	6.6	6.0	5.8	2.0	0.6	3.0	1.2	5.0	2.2
C./SW Uganda	AP	12.3	9.0	0.0	0.0	0.0	0.0	4.1	3.0	6.8	2.2
Means											
	AP	14.5	13.8	4.2	3.3	1.4	1.0	4.0	3.5	9.7	3.1
	PP	24.3	19.7	6.8	6.0	11.6	6.5	8.0	7.7	6.6	4.7
	Overall	18.8	16.5	5.4	4.5	6.0	3.4	5.8	5.4	8.3	3.8

1. AP = agropastoral; PP = pure pastoral.

3.6 Disease management

There was an intensification of diseases (both human and livestock) during the stress periods. Preventative measures were employed such as avoidance of susceptible areas, migration and hygienic practices. Disease treatment was mostly by ethno-therapeutic methods.

3.7 Assistance from the community and relatives

The percentages of households that reported that they received assistance from their communities and from relatives are presented in Table 40. Generally, more pure pastoralists than agropastoralists reported that they received assistance from their communities and from relatives. During both stress periods, S. Kenya agropastoral areas, C. Tanzania and NW Tanzania tended to report the lowest proportions of households that received assistance. More households received assistance from relatives than from their communities. There was a strong continuum of assistance from relatives, while, most community assistance was received during the drought.

Table 40. *Percentages of households per zone who reported that they received assistance from their communities and from relatives during each climatic phase.*

Type of assistance received	Zone	Pastoral category[1]	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
Aid from community							
	S. Ethiopia	PP	16.0	18.0	4.0	1.0	4.0
	N. Kenya	PP	33.0	42.0	35.0	35.0	30.0
	S. Kenya	AP	0.0	6.1	0.0	0.0	0.0
	S. Kenya	PP	0.0	1.1	1.1	2.3	1.1
	N. Tanzania	AP	0.0	0	0	2.9	0.0
	N. Tanzania	PP	4.9	3.3	4.9	6.6	3.3
	C. Tanzania	AP	1.0	2.0	0.0	0.0	0.0
	NW Tanzania	AP	0.0	0.0	0.0	0.0	0.0
	C./SW	AP	0.0	88.0	1.0	1.0	0.0

	Uganda						
	Means						
		AP	0.2	19.2	0.2	0.8	0.0
		PP	13.5	16.1	11.3	11.2	9.6
Aid from relatives							
	S. Ethiopia	PP	27.0	27.0	5.0	4.0	2.0
	N. Kenya	PP	56.0	60.0	54.0	52.0	45.0
	S. Kenya	AP	0.0	0.0	0.0	0.0	0.0
	S. Kenya	PP	0.0	3.4	1.1	0.0	0.0
	N. Tanzania	AP	5.9	8.8	2.9	8.8	2.9
	N. Tanzania	PP	4.9	9.8	9.8	6.6	4.9
	C. Tanzania	AP	0.0	1.0	1.0	1.0	0.0
	NW Tanzania	AP	1.0	4.0	1.0	3.0	0.0
	C./SW Uganda	AP	3.0	4.0	1.0	1.0	1.0
	Means	AP	2.0	3.6	1.2	2.8	0.8
		PP	22.0	25.1	17.5	15.7	13

1. AP = agropastoral; PP = pure pastoral.

3.8. External assistance provided to the pastoralists

Pastoral households received assistance from both their national governments and NGOs as indicated in Table 41. Across zones, more households received government aid than aid from NGOs. Pure pastoral areas reported far more households receiving aid than agropastoral areas. Pure pastoral areas also received aid more consistently through out the climatic phases than did agropastoral areas.

Table 41. *Percentages of households per zone reporting the receipt of external assistance from national governments and NGOs across the climatic phases surveyed.*

Type of external assistance	Zone	Pastoral category1	Pre-drought	Drought	Minor rains	El Niño rains	La Niña dry
Aid from national governments							
	S. Ethiopia	PP	7.0	31.0	0.0	0.0	4.0
	N. Kenya	PP	58.0	80.0	51.0	56.0	50.0
	S. Kenya	AP	0.0	21.2	3.0	3.0	0.0
	S. Kenya	PP	12.6	70.1	31.0	14.9	5.7
	N. Tanzania	AP	11.8	23.5	5.9	2.9	0.0
	N. Tanzania	PP	6.6	42.6	13.1	13.1	1.6
	C. Tanzania	AP	3.0	9.0	0.0	1.0	0.0
	NW Tanzania	AP	2.0	3.0	1.0	3.0	3.0
	C./SW Uganda	AP	3.0	4.0	5.0	3.0	3.0
	Means	AP	4.0	12.1	3.0	2.6	1.2

		PP	21.1	55.9	23.8	21.0	15.3
Aid from NGOs							
	S. Ethiopia	PP	6.0	14.0	0.0	0.0	0.0
	N. Kenya	PP	53.0	63.0	49.0	48.0	44.0
	S. Kenya	AP	0.0	3.0	0.0	3.0	0.0
	S. Kenya	PP	5.7	29.9	12.6	4.6	2.3
	N. Tanzania	AP	2.9	5.9	2.9	0.0	2.9
	N. Tanzania	PP	11.5	32.8	9.8	9.8	0.0
	C. Tanzania	AP	2.0	6.0	0.0	1.0	0.0
	NW Tanzania	AP	1.0	2.0	1.0	7.0	1.0
	C./SW Uganda	AP	0.0	0.0	0.0	0.0	0.0
	Means	AP	1.2	3.4	0.8	2.2	0.8
		PP	19.1	34.9	17.9	15.6	11.6

1. AP = agropastoral; PP = pure pastoral.

This could indicate either reliance on aid, or subsidisation of pastoral economies. In general, more households reported that they received aid from their governments and NGOs than from relatives and local communities. N. Kenya reported more households receiving aid from governments and NGOs than any other zone. Nonetheless, pastorlists noted that aid received was neither sufficient, nor timely.

4 Discussion of findings, recommendations and general conclusions

4.1 Discussion of study findings

Pastoral peoples have to eke a living out of some of the most unstable environments in the world. They are vulnerable to the effects of adverse climatic occurrences, especially droughts whose frequency is rising with increasing global warming. Emphasis by governments and NGOs that extend assistance to pastoralists to cope with the effects of crises, particularly drought, is currently shifting from relief to resource management and capacity building strategies. This emerging focus on drought preparedness is aimed at making pastoral communities more resilient to shocks when they come, so that the negative impact of subsequent shocks is minimised. More capacity is thereby reserved for the next crisis thus perpetrating a sustainable relay mechanism. However, little information is available on the types of appropriate mechanisms to prepare pastoral communities to better cope with these shocks (de Haan and Gauthier 1999).

This survey gathered information on some of the coping mechanisms practised by pastoralists including movement and migration in search of water, forage and work. Livestock grazing was supplemented, on a small scale. Other herd management strategies employed included maintenance of a female dominated herd structure with uncontrolled breeding and diversification by livestock species. Herd size accumulation and partitioning into core and satellite herds were also observed. Pastoralists shared, loaned or gave gifts to aid each other during the stress periods. Their diets reflected the food types available during the various phases. Disease management practices included good hygiene and ethno-therapy. External assistance was received from relatives, the community, national governments and NGOs. The majority of pastoralist households that received some assistance were assisted by governments. However, in general, the pastoralists reported that assistance was too little and arrived too late.

Some strategies for coping during crisis periods differed in extent between pure and agropastoralists. Pure pastoralists trekked longer distances than agropastoralists in search of water and forage for their livestock during the drought. More agropastoralist than pure pastoralist households fed crop residue as a supplementary feed to both cattle and small ruminants; conversely, more pure pastoralists fed shrubs and fodder tree leaves. Most supplementary feeding, albeit practised by very few pastoralists overall, occurred during the pre-drought and drought periods. More cattle were loaned for milk, meat, herd establishment, disposal and herd dispersal by pure pastoralists than agropastoralists, with the exception of loans for herd dispersal during drought. Frequent consumption of vegetables, fruits, meat, milk and milk products, and cereals/grains was reported by 36%, 13%, 11%, 15% and 26% more agropastoralist households, respectively, than pure pastoralist households. Most of the little external aid provided during crisis periods went to pure pastoralist areas.

The stress periods, of drought and El Niño rains, adversely affected the natural resources.

Drought had severe effects on availability of, and access to water and forage resources. Emergency sources were utilised; however, some of the emergency water sources carried a mandatory fee, thus aggravating the crisis for most pastoralists. One of the major adverse effects of the El Niño phase was intensification of disease.

The pure pastoral zones were more affected by the drought and El Niño floods than the agropastoral zones in terms of effects on the natural resources, mortalities and disease. On average, 37% of the pure pastoralist households reported that they had enough forage for their livestock pre-drought but this figure declined to only 1% at the peak of the drought compared with 58% and 3%, respectively, for the agropastoralists. Livestock mortality per household was significantly higher in pure pastoral zones as a result of the effects of both the drought and the El Niño rains. A higher proportion of pure pastoralist than agropastoralist respondents reported incidences of cattle disease during the drought. More human deaths as a result of illnesses were also reported for pure pastoralist areas compared with agropastoralist areas during the drought.

The stress periods had similar effects on neighbouring zones, with impact being most severe on the most arid zones, i.e. S. Ethiopia and N. Kenya and least on the neighbouring zones of C./SW Uganda and NW Tanzania. Of all the livestock species, cattle were most affected by drought and small ruminants by the El Niño rains.

The immediate impact of severe drought is the serious decimation of livestock herds. Significant cattle losses attributable to drought were recorded in all the arid zones surveyed. The more arid zones of S. Ethiopia, N. Kenya and S. Kenya and neighbouring N. Tanzania lost more cattle than the less arid zones. For example, the cattle losses of 35% recorded in the arid areas of Kenya were comparable with the losses of 33% and 38% reported respectively for the 1984 and 1992 droughts (Mutea and Lelei 1994).

Mortality figures obtained in this study indicated that the young animals (calves, lambs and kids) were highly vulnerable during climatic stress phases. Coppock (1994) noted that high calf mortality was detrimental to the pastoral economy, affecting the strategy of herd accumulation as an ex ante practice to climatic stress periods. In a few zones, there was high and unexpected mortality of bulls. This could reflect the difference in management strategies accorded to satellite and core herds and/or the influence of disease. Disease incidence intensified during both stress periods, increasing mortality of livestock.

Camels are much more resilient to drought than the other livestock species. Both Stock Watch Ltd. (1994); Mbogoh (1997) observed a 13% and 21% reduction in the camel population in N. Kenya after the 1984 and 1992 droughts, respectively, compared with 40% to 50% for other livestock species. A similar trend was observed in this survey; camel mortality was 23% and 18% compared with 49% and 35% for cattle in S. Ethiopia and N. Kenya, respectively.

The suggested desirable and sustainable annual cattle offtake for pastoralist production systems is in the range of 11–13.5% (Mbogoh 1997). This survey observed a much lower overall average of 5.2% total offtake over the entire study period for all zones. This is even lower than the annual figure of about 7.6% reported by Mbogoh (1997) for arid and semi-arid lands (ASALs) of Kenya. Stock Watch Ltd. (1994) argues that this offtake level for ASALs of Kenya can be increased by addressing a number of primary constraints to livestock marketing. The constraints include long distances to markets with poor infrastructure and lack of water for livestock along the routes. Other constraints are movement restrictions due to disease quarantine, lack of security due to conflicts between communities, lack of credit facilities for livestock traders and poor market information systems. Since only sustainable solutions are likely to have a significant impact, useful lessons may be learnt from past efforts to face some of these challenges. For instance, the Kenya Livestock Development Project (KLDP) which aimed to improve livestock production and marketing was initiated in 1968. This project resulted in building or improvement of facilities but these could not be sustained due to lack of maintenance. Other aspects of the project, such as range improvement and control of stocking routes, failed altogether to achieve their goals (Mbogoh 1997).

Sales, purchase and slaughter rates in this study indicate a 9% offtake over all zones for small ruminants (7% sales, 2% slaughter) which is higher relative to that for other livestock species. During the El Niño and La Niña dry phases, a slight increment in livestock purchases, especially purchases of cattle, was recorded as pastoralists began to restock their herds.

Livestock diseases endemic in most of the countries of the GHA include the epidemic/infectious diseases such as rinderpest, contagious bovine pleuro-pneumonia (CBPP) and CCPP. Foot-and-mouth disease (FMD) does not cause high mortalities but is an epidemic, highly infectious disease that causes severe economic losses due to reduced productivity as well as trade restrictions in livestock and livestock products. Important parasitic and viral diseases include trypanosomosis and tick-borne diseases, particularly theileriosis (Gathuma and Mutiga 1997).

In times of severe drought, pastoralists move long distances with their livestock in search of forage and water. These movements have serious health implications. The animals which are then under nutritional as well as physical stress, succumb easily to diseases. Physical stress results from long distance movement and overcrowding due to unplanned movement. Some animals may die on the journey while others carry and transmit diseases to new areas. It is also common practice to move animals to valleys in search of forage and water during drought. These areas may be infested with tsetse flies, leading to economic losses in the purchase of trypanocidal drugs as well as animal mortality. The debilitating effects of disease are exacerbated by nutritional stress during drought.

Crises caused by civil strife also result in mass exodus of livestock with similar health implications to those induced by drought. Above all, the sharing of grazing and water resources by animals from different areas as well as wildlife, exposes them to the risk of disease transmission. Effective strategies for coping must therefore include the management of both livestock movements and water and grazing resources as well as disease control.

4.2 Recommendations and implications for timely intervention (early warning and mitigation)

1. NDVI data were used to delimit the climatic phases. The stipulated model for the use of NDVI data in the LEWS for eastern Africa was summarised by Dyke (1999). The model indicates that: a watching status should be imposed at a 0% deviation from the norm; an official alert issued at a deviation of –10%; and an emergency signal at a deviation of –20%. The impacts of our study indicate that the benchmarks for warning national governments should be instituted at low levels of deviation in order to evoke national and international intervention at stages when intervention will safeguard and promote the pastoral economies. This survey indicates that institution of an alert at a deviation of –20% would result in a crisis characterised by food shortages and even human deaths, warranting food aid to rectify the situation. Food aid interventions in fact signal that the monitoring indicator was either inappropriate or applied too late.
2. Movement and migration in search of resources was a key strategy. Issues pertaining to movement and migration management need to be addressed in the face of increasing population pressure and the consequent reduction in scope for lateral movement of livestock and humans. Issues for investigation include decision making in relation to: which animals are put into the core and satellite herds; when movement begins; who is left in the homestead or migrates; and how scouts locate grazing etc. Migration and movement also impact on other issues such as the spread of disease and may cause

conflicts; these issues also need to be addressed. Moreover, effectiveness of migration strategies should be examined; for example, survival rates within the satellite vs. the core herds should be investigated.

3. This study assessed the level of aid given to pastoralists by examining the percentage of households that received aid from various sources (relatives, community, governments and NGOs). It is recommended that appropriate aid should promote the pastoral economy and not create a situation of perpetual dependency, as is often seen with food aid.
4. There was a high level of mortality amongst young animals (calves, kids and lambs). Coppock (1994) noted that a high level of calf mortality is a major threat to pastoral economies. Calves and small ruminants are, generally, reared intensively by women and children around homesteads or encampments. Women also treat diseases amongst the calves and small ruminants. Issues pertaining to the skills and knowledge of women and children should be examined; for example, what ethno-therapeutic knowledge and skills do women and children have and are veterinary facilities accessible to women? The diseases that cause the most calf and small ruminant deaths should be documented.
5. Supplementation of livestock grazing with other feeds was practised in all zones, albeit at low levels. Possibilities of promoting supplementation should be explored. Coppock (1994) reported that Borana pastoralists in Ethiopia had started the practice of growing fodder banks as dry season feed reserves for calves and small ruminants. The viability of this practice should be examined.
6. Conflict and issues of conflict resolution were not addressed by this survey; however, the pastoralists referred to them. Conflicts arise from the conflicting interests of multiple users sharing a common resource. Moreover, they arise from or impinge on other issues related to the pastoral way of life. For example, unrestricted water development may result in conflict and land degradation. Some of the survey respondents explained that they were not able to access certain water sources because of religious conflicts. Conflicts affect marketing and also increase the potential for the spread of disease epidemics, particularly when households move to safer places, or rustlers move livestock across borders. The factors that trigger and fuel conflict need to be addressed, as well as strategies for conflict resolution.
7. Effect of climatic stress and the efficacy of coping mechanisms used by the disadvantaged sectors of the pastoral populations were not examined. Other studies (Coppock 1994) document that the poorest sectors of society are more adversely affected than the rest of the populace. This issue needs to be examined and addressed.
8. Recent statistical and dynamic weather forecast models can forecast emerging La Niña and El Niño episodes several months in advance. Linkages with weather forecast and climatology agencies should be enhanced in order to use data generated by these models to compliment and add value to present mitigation efforts.

4.3 General conclusions

Coppock (1994) noted that human response to drought consists of adjustments over time to perceived stress. The stress periods are thus viewed as phenomena of progressive severity towards a peak stress period and a waning towards recovery from the stress. The indicators in this survey, e.g. sale of more small ruminants than larger stock such as cattle and camels, loaning and transfer of livestock, and migration of some household members in the search for work are consistent with Corbett's (1988) description of the 'insurance stage' of coping with a crisis. Corbett (1988) described the insurance stage as one in which essentially the pastoralists employ buffering measures and strategies. The next stage, which Corbett (1988) describes as the 'crisis stage' involves disposal of more productive assets and seeking of credit, amongst other behaviours. Distress migration follows, characterised by mass migration and loss of human lives.

Various coping mechanisms were applied, either through intensification of ex ante strategies or institution of crisis management strategies. However, losses of livestock were high, indicating that either the indicator signals were inappropriate or applied late, or the coping mechanisms were not adequate to address the situations. There is a need to document the indicators used by pastoralists and the decision process towards the institution of the different coping mechanisms. Interventions should appreciate the indigenous knowledge exemplified in the currently applied coping mechanisms and yet focus on strengthening the ability of pastoralists to live off the precarious rangeland. As Kottak (1991) succinctly stated ' … the goal is that of changing so as to maintain: i.e. minor [specific] changes [are introduced] so as to preserve a system [pastoralism] while making it function more effectively [productively and sustainably]'. This study was by no means exhaustive; however, it gives insight into the trends of the impacts of the stress periods, the 1995–97 drought and the 1997–98 El Niño rains. The results will form the basis for the institution of the local, national and regional livestock early warning systems.

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Appendix I Coping mechanisms survey questionnaire form

The effects of the 1995–97 drought and 1997 flood, pastoralists' coping mechanisms to these environmental stresses, and the efficacy of the coping mechanisms as perceived by the pastoralists.

Survey number:..............................Date: …………………………

Interviewer:.......................................Location code:..................

GPS (global positioning system).

	Longitude		Circle	Latitude	
	Degree	Decimal minute	N	Degree	Decimal minute
E			S		

I & II What are the effects of, and responses to, the 1995–97 drought and 1997–98 flood as perceived by randomly selected pastoralists in the five East African nations of the LEWS project?

(Response = coping mechanism)

A Local economy: Effects and responses on the livestock herds (risk minimising and loss management strategies)

(See questions attached for tables)

1. Livestock production responses to drought—tables (see I.A.1 appended)
2. How many water sources for your livestock did you have access to before the drought, during the peak of the drought, at the onset of the wet season that brought the drought to a close, at the peak of the flood, and when the flooding subsided?
3. As I mention each phase of the drought and flood we have been discussing, please tell me how many kilometres to the primary water source and emergency water source for your livestock?
4. Then, I will ask how many kilometres per day from your homestead did you have to travel to reach your livestock's primary grazing site and the site you had to use in emergencies.

Questions 2–4	Drought (1996–97)		Flood (1997–98)		
Movement	Pre-	Peak	Onset of rains	Peak	Recovery
Number of primary water sites					
Km to primary water					
Number of emergency water sites					
Km to emergency water					
Km to primary grazing					

5. What type of water sources were they?

Type of water source	Drought		Flood (1997–98)		
	Pre-	Peak	Onset of rains	Peak	Recovery
Bore hole					
Hand dug wells					
Digging in stream beds					
Ponds					
Concrete, in ground					
Concrete, above ground					
Reservoir/dam					
Other					

6. Did you use any vehicle transport for family or livestock in large-scale movement during the drought or flood times? If yes, what type? (Note to enumerator: Place cost/head in the appropriate box).

Yes____ No____

Transport	Drought		Flood	
	Family	Livestock	Family	Livestock
Common truck (shared)				
Contracted truck				
State owned truck				
Other				

7. Did you fence to protect the water sources?

Yes____ No____

8. Did you have to move from your household village because of flood water?

Yes ____No ____

Why? ________________________________

Distance moved (km) _____________

Given warning? Yes ____ No____

9. In times of drought and/or flood, did you see any of the following diseases, or disease symptoms, among your livestock or other people's stock nearby? Which stock (yours or someone else's) had symptoms of these diseases or other diseases? What was the most common treatment for these problems?

Examples for each livestock disease category include: (1) Epidemic/infectious: rinderpest, contagious bovine pleuro-pneumonia (CBPP), contagious caprine pleuropneymonia (CCPP), peste des petits ruminant (PPR), foot-and-mouth disease, foot rot, anthrax, black-quarter, brucellosis, sheep and goat pox, pneumonias of newborn; (2) Parasitic/viral: trypanosomosis, theileriosis, cowdriosis (heartwater), anaplasmosis, Rift Valley fever, babesiosis, dermatophilosis, African swine fever, Nairobi sheep disease, blue tongue, rabies, gastro-intestinal parasites; and (3) Condition: malnutrition, diarrhoea, mastitis, mineral deficiencies.

If any of these diseases/conditions are mentioned by the respondent, record in the appropriate categorical box. If diseases or conditions are mentioned that are not listed, record in the 'Other' boxes and give name and description.

Animals: 1 = cattle; 2 = sheep/goats; 3 = camels; 4 = horses/mules/burros; 5 = other
Treatment: 1 = vaccine; 2 = quarantine; 3 = dip/spray/pour-on; 4 = drench; 5 = traditional medicine; 6 = destroy; 7 = vector control; 8 = other

	Drought		Flood		
Livestock disease/condition	Respondent's stock	Other's stock	Respondent's stock	Other's stock	Treatment
Epidemic/infectious					
Parasitic/viral					
Condition					
Other ( )					
Other ( )					

Description of unlisted diseases/conditions:

10. Did you provide your livestock any of the following supplemental feed materials before the drought, during the peak of the drought, at the onset of the rains, during the peak of the flood, and/or in the recovery period from the flood? About how much each day did you give the animals? (Note to enumerator: place approximate amount/day in the appropriate box).

	Drought				Flood					
	Pre-		Peak		Onset of rains		Peak		Recovery	
Feedstuffs	Animals	Kg	Animals	Kg	Animals	Kg	Animals	Kg	Animals	Kg
Grain										
Protein meal										
Grain by-products										
Crop residue										
Forage (kg)										
Shrub/tree fodder										
Other										

Animals: 1 = cattle; 2 = sheep/goats; 3 = camels; 4 = horses/mules/burros; 5 = other

11a). Did sickness, or any other human issues (family problems), cause you to manage animals in a way that you would not do normally? What did you do differently?

Yes ____No____

11b). What was the most significant livestock management change?

B Environmental/natural resources: Effects and responses on the rangeland

1. Which of the following scores best describes your forage availability before the drought, during the peak of the drought, at the onset of the rains that brought the close of the drought, before the flood, during the peak of the flood, and after the flood? What was the most common way you dealt with insufficient forage?

Score: 1= very little; 2 = marginal; 3 = enough for your animals; 4 = excess of your animals' needs

Environmental stress phase	Score	Response
Pre-drought		
Peak of drought		
Onset of rains		
Peak of flood		
Recovery		

2. Did you notice a major loss of your better grass after recovery from the drought?

Yes ____No ____

3. Did you share your rangeland areas with anyone from communities outside your traditional grazing boundaries? If yes, was the sharing only during drought and/or flood times, or during normal times, as well?

Yes ____No ____Drought ____Flood ____Normal ____

4. Did other communities share their traditional grazing land with you? If yes, was the sharing only during drought and/or flood times, or during normal times, as well?

Yes ____No ____Drought ____Flood ____Normal ____

C Socio-economic factors

1. Did the number of herding labour remain the same, increase, or decrease during each phase of the drought/flood times?

Score for number of herding labour: 0 = remain the same; 1 = increase; 2 = decrease

	Drought		Flood		
	Pre-	Peak	Onset of rains	Peak	Recovery
No. of herding labour					

2. Did you loan any cattle to anyone during any phases of the drought/flood? If yes, for what purpose (see Table in question 3)?

Yes ____ No____

3. Did anyone loan any cattle to you during any phases of the drought/flood? If yes, what was the main purpose (see table)?

Yes____ No____

Place appropriate number in appropriate box: 1 = respondent loaned livestock; 2 = someone loaned livestock to the respondent.

Questions 2 and 3	Drought		Flood		
Purposes:	Pre-	Peak	Onset of rains	Peak	Recovery
Milk for family consumption					
Holding for someone working elsewhere					
Meat to cover shortages					
Herd re-establishment					
Disperse excess animals					
Other					
Other					

4. How many people, on the following list, stayed behind (at the homestead) when there was an emergency move to better grazing lands?

Women _____

Children _____

Teenage men _____

Men (age = 20–40) _____

Men (age = 41–60) _____

Men (age >60) _____

Other: _____________ _____

5. What were the reasons for leaving them behind?

a. Journey too long____

b. Stayed with small stock____

c. Extended family care____

d. Illness____

e. Location of stable water ____

f. Location of stable forage ____

g. Other ( ) ____

6. Did the people that were left behind join you, at a later time, at the emergency location?

Yes _____No _____Not applicable _____

7. Were there any legal restrictions, with respect to how you cope with the drought and/or flood, that effect your ability to care for your livestock? What was the most common legal restriction?

Yes ____No____

Most common legal restriction:_______________________

8. Were there any traditional restrictions, with respect to how you cope with the drought and/or flood, that effect your ability to care for your livestock? What was the most common traditional restriction?

Yes ____No____

Most common traditional restriction:_____________________

9. Did you have to draw upon stores of food, pledge or sell assets, seek new sources of food, e.g., wild foods and animals, during the drought and/or flood times?

	Drought		Flood		
	Pre-	Peak	Onset of rains	Peak	Recovery
Stored foods					
Pledge assets					
Sell assets					
Seek new food sources					

10. Did you have to disperse family members, livestock, assets and/or migrate to meet your family’s needs during any phase of the drought and/or flood? Explain.

	Drought		Flood		
Disperse/migrate	Pre-	Peak	Onset of rains	Peak	Recovery
Family members left for work					
Family members left to give or receive care					
Livestock					
Assets					
Migrate					

Explanation:

11. Did you have to borrow, share and/or provide other assistance during drought and/or flood times? Explain.

	Drought		Flood		
Communal coping	Pre-	Peak	Onset of rains	Peak	Recovery

Borrow						
Share						
Other assistance						

Explanation:

D. Pastoral welfare: Effects and responses on household

1. What type of water sources for your family did you have access to before the drought, during the peak of the drought, at the onset of the rains that brought the drought to a close, peak of the flood, and when the flooding subsided? How many kilometres was (were) the source(s) from your household village?

Scale for types of sources: 1 = borehole; 2 = well; 3 = pond/trench; 4 = river/stream; 5 = hauled; 6 = other

Human water sources	Drought		Flood		
	Pre-	Peak	Onset of rains	Peak	Recovery
Type of water source					
Number of km from household village					

2. How did the water shortage affect your drinking water, food preparation, bathing, laundry efforts, and/or other things for your household? What was the main way you compensated for the shortage?

An example: an effect of the drought and flood on drinking water = decreased quantity of quality water (uncontaminated). Responses might be to consume less water and take greater risk by consuming lower quality water.

Consumption item	Drought		Flood	
	Effect	Response	Effect	Response
Drinking water				
Food preparation				
Bathing				
Laundry				
Other				

3. What are some of the foods that you and your family eat in good times? What about in hard times, like during the drought and the flood? How frequently did your household eat the following items (listed in the table)?

Scale for frequency of food eaten: 0 = never; 1 = occasionally; 2 = frequently; 3 = most of the time

Food type	Drought		Flood		
	Pre-	Peak	Onset of rains	Peak	Recovery
Cereals/grains					
Milk and milk					

products					
Meat					
Vegetables					
Fruits					
Other					

4. Did you see any of the following human illnesses in normal, drought, and/or flood times ? How often? What other diseases were prevalent in drought and/or flood times that were not during normal times (list by 'other')?

Examples for each human disease category include: (1) Epidemic/infectious: tuberculosis, typhoid, cholera, AIDS; (2) Parasitic/viral: trypanosomosis, malaria, Rift Valley fever, gastro-intestinal parasites; and (3) Condition: malnutrition, diarrhoea, mastitis, mineral deficiencies (Problem = Few visible symptoms point only to mineral deficiency).

If any of these diseases/conditions are mentioned by the respondent, record in the appropriate categorical box. If diseases or conditions are mentioned that are not listed, record in the 'Other' boxes and give name and description.

Scale for number of times each type of human illness was observed: 0 = never; 1 = occasionally; 2 = frequently; 3 = most of the time

Human disease/condition	Drought		Flood		
	Pre-	Peak	Onset of rains	Peak	Recovery
Epidemic/infectious					
Parasitic/viral					
Condition					
Other					

5. Was there an increase in illness in your household during the drought and/or flood time?

Drought: Yes _____ No _____ (if no, skip no. 6)

Flood: Yes _____ No _____ (if no, skip no. 6)

Enumerator beware!! You must be very sensitive in how you ask this next set of questions (No. 6)!

6. If there was an increase in illness in your household, what type of illness was it? What was the most common method used to improve the health of the one suffering the illness? Was there a death in the household that can be attributed to one of these illnesses or another illness, during the drought and/or flood? Refer to disease/ condition descriptions in no. 4.

Type of illness	Drought		Flood	
	Treatment	Death	Treatment	Death
Epidemic/infectious				
Parasitic/viral				
Condition				
Other				

7. What are the most common things done to try to prevent the following types of illness?

Refer to disease/condition descriptions in no. 4.

Type of illness	Preventive measures
Epidemic/infectious	
Parasitic/viral	
Condition	
Other	

III What type of assistance was provided to the pastoralists to mitigate the drought and/or flood effects?

1. Did you and your family receive help from relatives, patrons, community, or an agency during drought, flood, or normal times?

Assistance	Drought		Flood		
	Pre/normal	Peak	Onset of rains	Peak	Recovery
Relatives					
Patrons					
Community neighbours					
Government					
NGO					
Private agency					
Other					

If you did not receive help, why not?

2. How did you find out about __________? (Fill in the blank with the agency from whom they received help).

a. Relative _____ e. Bank_____

b. Patron______ f. Media (e.g. Newspaper, radio, etc.)_____

c. Community neighbours _____ g. Other ( )_____

d. Agency representative_______

3. What did you have to do to get the assistance? As answer is given, fill in the blanks and write anything left out of our listing.

a. Travel to city to fill-out application ____

b. Distance to city ____

c. Transportation ____

d. Length of application ____

e. Needed help to complete form(s) ____

f. Time between applying and being notified of grant ____

g. Time between notification and receipt of assistance____

h. Manner in which aid came:

Return to city ____

Mail service ____

Agency representative brought it ____

Other ____

i. Other procedures: ____

IV What are the effects/consequences (positive and negative) of the identified coping mechanisms?

1. What were the three most useful things you did during each phase of the drought and flood to help you adjust to the situation?

a.

b.

c.

V What are the pastoralists' perceptions of how well the assistance 'fitted the need'?

1. Did the claim/assistance from the agencies mentioned meet the need you hoped it would meet? Why or why not?

Agency	Yes	Why	No	Why not
Government				
NGO				
Private				
Other				

Continue explanation:

Human demographics

1. Name/interview code: _______________

2. Age:

20s ____ 30s ____ 40s ____

50s ____ >59 ____

3. Religion:

African traditional ____ Christian ____ Muslim ____ Other ____

4. Formal education:

None ____ Read and write ____

5. Relative economic status:

Higher than most ____ Lower than most ____ Same as most ____

6. Household members:

Total number of persons living in household ____

Male children _______

Female children _______

Male teenagers _______

Female teenagers _______

Male adults _______

Female adults _______

Male elderly _______

Female elderly _______

I.A.1 Livestock production effects and responses to the 1995–97 drought and 1997–98 flood: Instructions to enumerators

Enumerator needs to explain the phases of the drought and flood (as provided below):

- Pre-drought: this is the same as 'normal times' before the 1995–97 drought occurred.
- Peak of drought: this is at the most difficult time of the drought.
- Onset of rains: this is the wet season that broke the drought period and before the 1997–98 flooding.
- Peak of flood: this is at the most difficult time of the flooding.
- Recovery: this is when the flooding stopped and life began returning to a period of time closer to normal times.

Enumerator leads the respondent through each phase: (a) before the drought; (b) during the peak of the drought; (c) when the rains finally came, (d) at the peak of the flood, and (e) when a time of recovery came.

For each phase of the drought and flood, please answer the following questions:

Cattle:

1. How many mature bulls and cows and replacement heifers did you have?
2. How many calves were born?
3. How many mature bulls and cows, replacement heifers, and calves died?
4. How many mature bulls and cows, replacement heifers, and calves did you sell?
5. How many mature bulls and cows, replacement heifers, and calves did you give as gifts?
6. How many mature bulls and cows, replacement heifers, and calves did you receive as gifts?
7. How many mature bulls and cows, replacement heifers, and calves did you loan to

someone?

8. How many mature bulls and cows, replacement heifers, and calves did someone loan to you?
9. How many mature bulls and cows, replacement heifers, and calves did you slaughter?
10. How many mature bulls and cows, replacement heifers, and calves did you buy?

Ask the same questions as above, except for sheep, goats, camels, horses/mules/ burros and other livestock.

Appendix II Coping mechanisms survey participants[1]

1. *= LEWS in-country co-ordinator; ** = LEWS zonal co-ordinator; ***LEWS team member.

Southern Ethiopia

Z. Sileshi*, A. Ebro***, A. Hassen, A. Tsigaw, A. Mengistu, F. Dawro, G. Kebede, H. Dadi, M. Asfaw, M. Guru, M. Gulye, M. Chala, S.T. Mariam, S. Bediye, T. Mirkina, T. Abebe, T.A. Aredu, T.A. Ticho, Z. Kssay

Northern Kenya

P. Kamau**, R. Shavulimo, M. Wekesa, G. Leparteleg, W. Huri, G. Umuro, S. Leborkwe, L. Leruk, H. Umuro, E. Koono, J.E. Lim, S.E. Kachurlwel, D. Silale, G. Mwanika, H. Lentaaya, D. Lolosoli, R. Lemerdete, C. Lemoonkai, Lembara, S. Emanikor, L. Lodee, J. Ekiru

Southern Kenya

W.N. Mnene*, P. Wandera***, J. Waweru, D.S.K. Amungah, M.T. Latonga, S. Oloiputari, J.N. Musyoka, P. Solitei, B.K. Korir, J.K. Githinji, L.O. Andunga, A.G. Angwenyi, F. Kunyanga, J.L. Munge, A.M. Muraguri, L.L. Lemiso, H. Wanganga, S.S. Tipanko, Magiri, Ndighila, Oboma

Northern Tanzania

S.N. Bitende**, R.N. Mero, M.N. Kingamkono, N. Mollel, M. Hassan, A. Fungomali, M. Khalid, R. Semwenda, F. Ndaikya, L. Kilongola, M. Nkide, A. Pallangyo, G. Ngwijo, A. Mnzava, J. Manzi, D. Chalamira, V. Mlawa, D. Cheyo, P. Bundala

Central Tanzania

A.J. Mwilawa**, D.S. Sendallo, E. Palangyo, Ulomi, R. Urassa, E. Kasanga, O. Mwachambi, A. Mtalla, E.H. Goromella, C.R. Ulime, L.F. Macha, E. Limu, Semadio, Mchalla, P. Mwiru, P. Lyimo, O. Bungile, A. Mwenda, F. Abraham, D. Shayo, M. Joseph, T. Lebabu

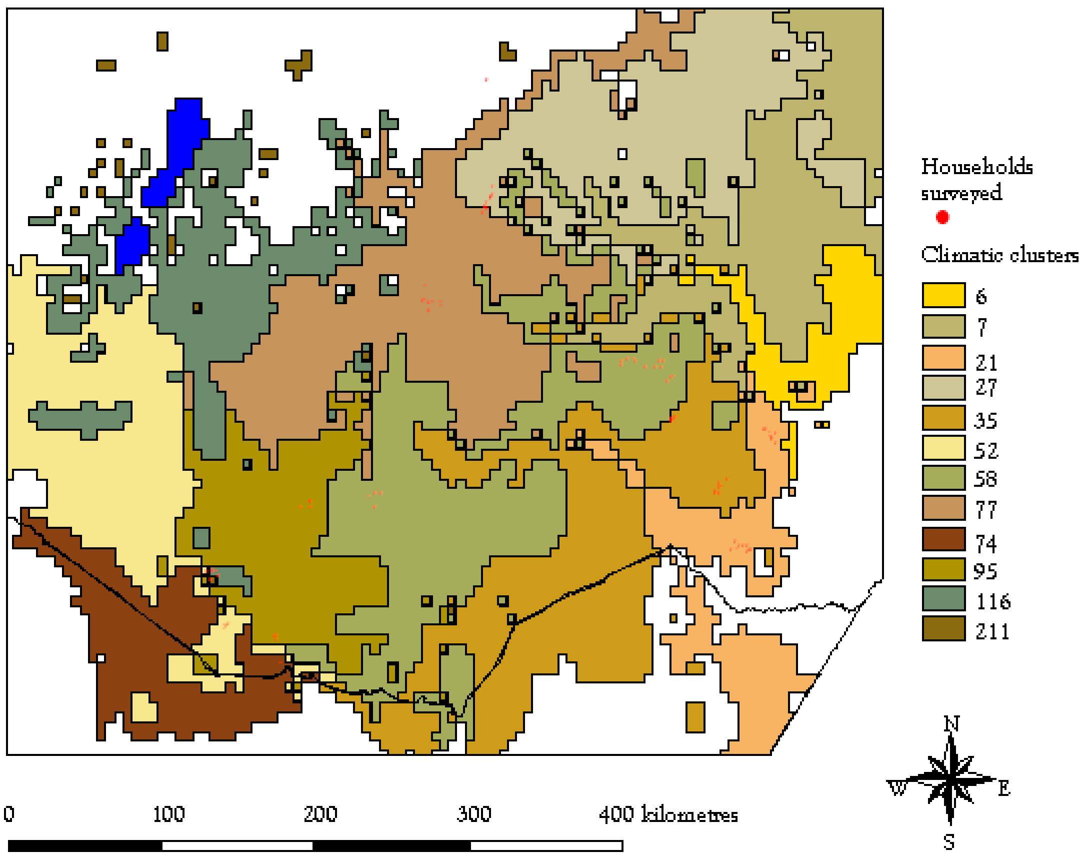
North-western Tanzania

S. Kaganda**, E. Wella, N. Ngulinizila, R. Sawe, J. Minani, W. Samamba, Mkulati, S. Mkumbo, H.J. Senzota, S. Kissamba, A. Ganja, G. Mkumbo, G. Mbwambo, L. Aloys, J. Kassimba, J. Madusa, Y. Mchengwa, C. Ndagile, G. Clement, J. Mtwale, D. Cheyo, P. Bundala

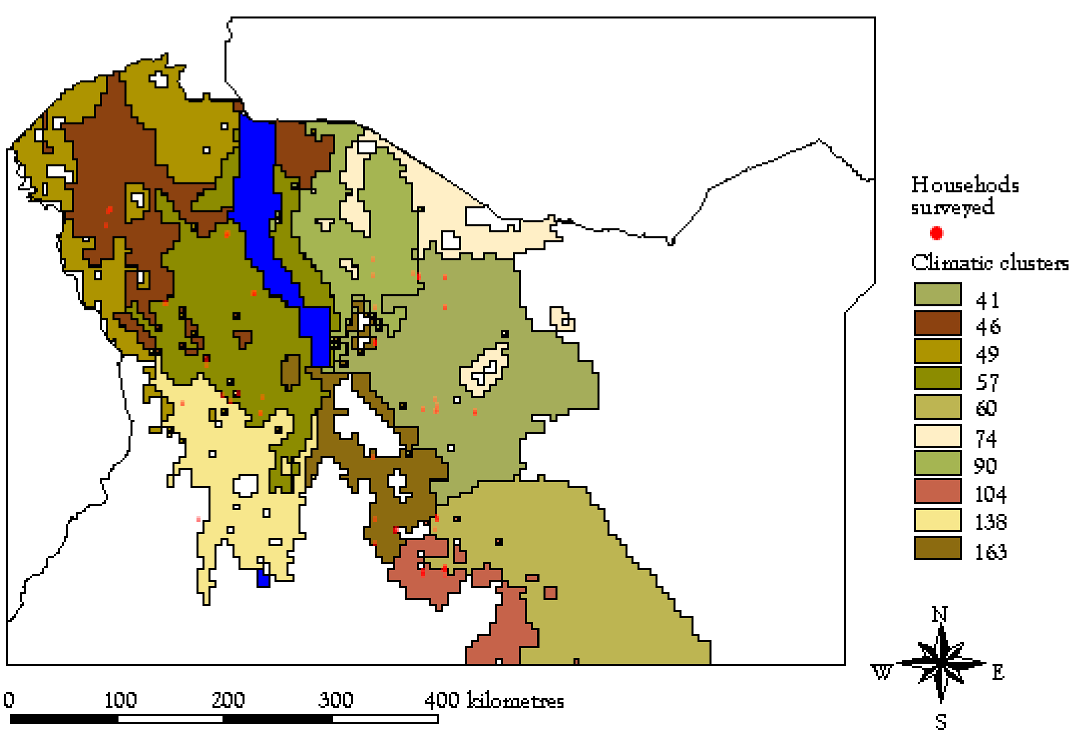
Central/south-western Uganda

C. Ebong*, G.S. Byenkya**, F.B. Bareeba***, Magona, L. Aziku, G. Ebyau, A. Namagambe, S. Kayiwa, J. Kigongo, C. Sudhe, A.S. Sali, R. Makumbi, J. Sekate, E.J. Kayira

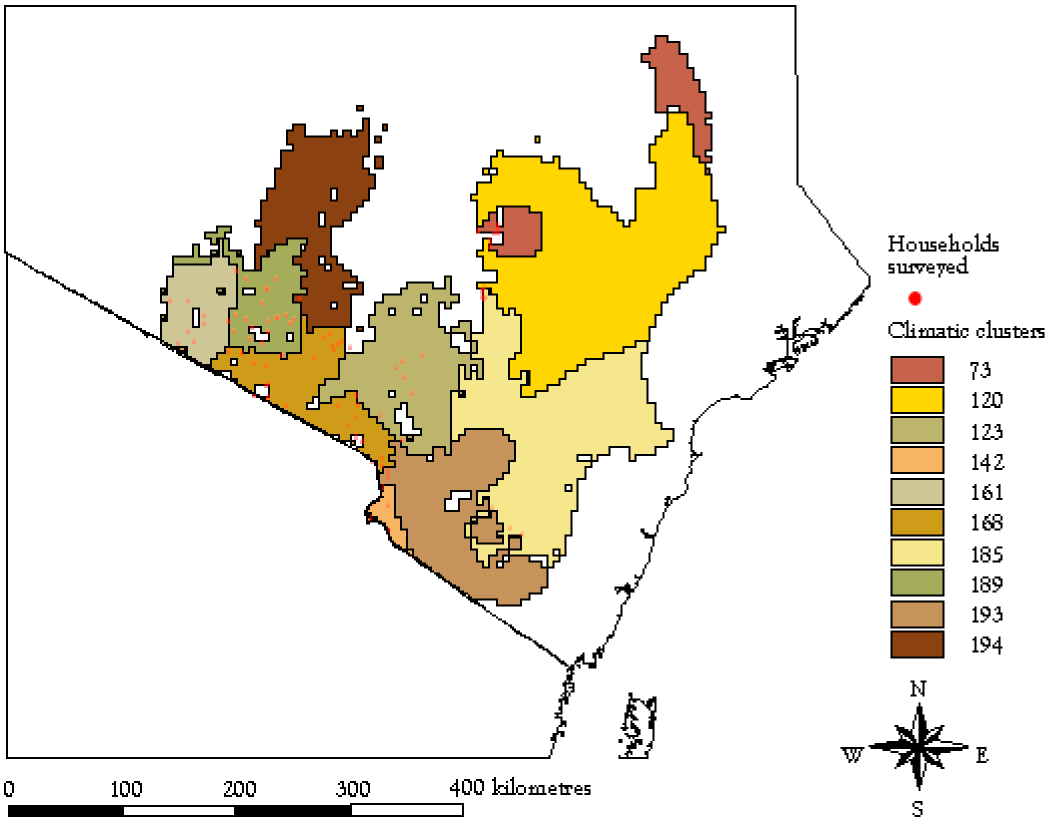
Appendix III Distribution of households surveyed



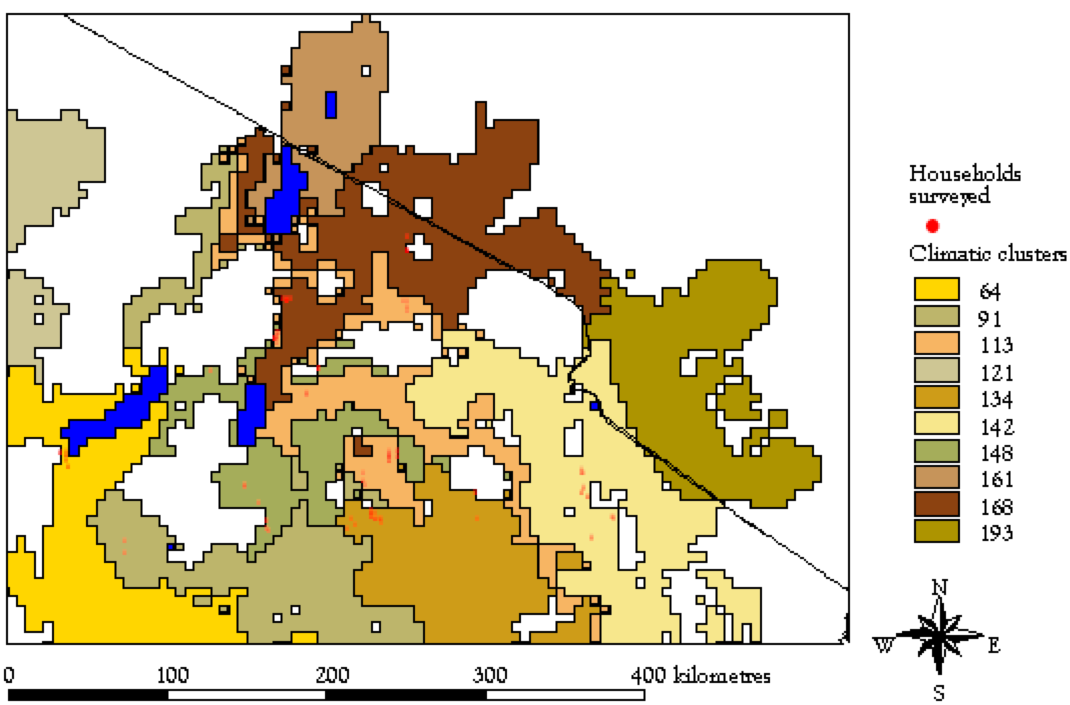
Map 1. *Climatic clusters and households surveyed in southern Ethiopia.*



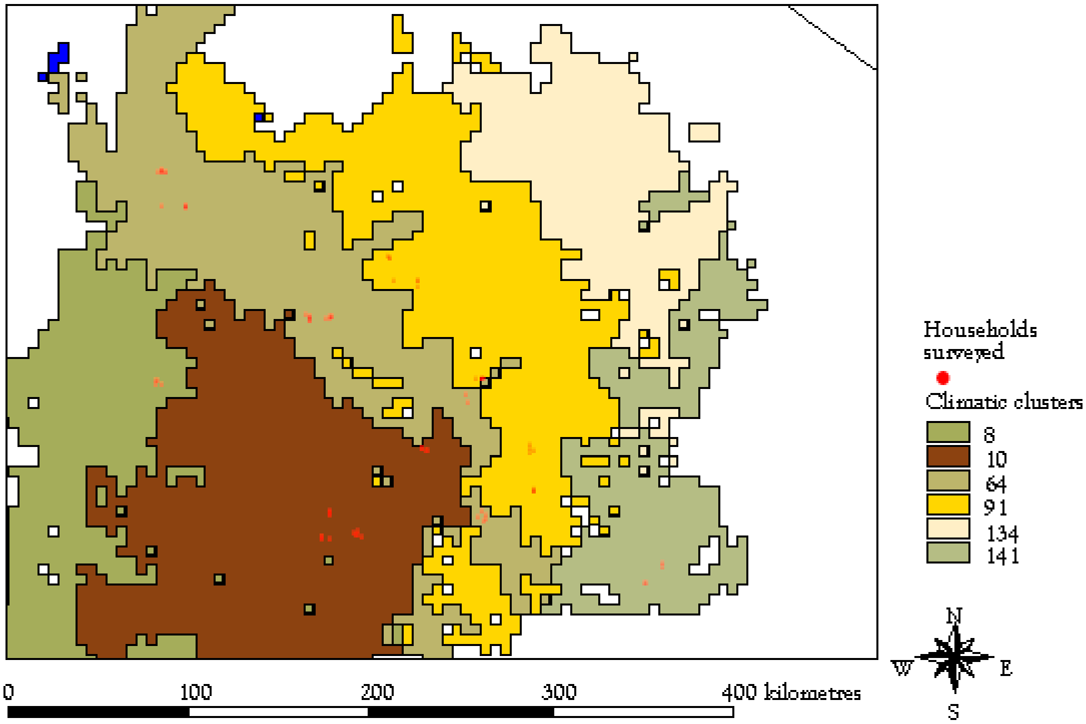
Map 2. *Climatic clusters and households surveyed in northern Kenya.*



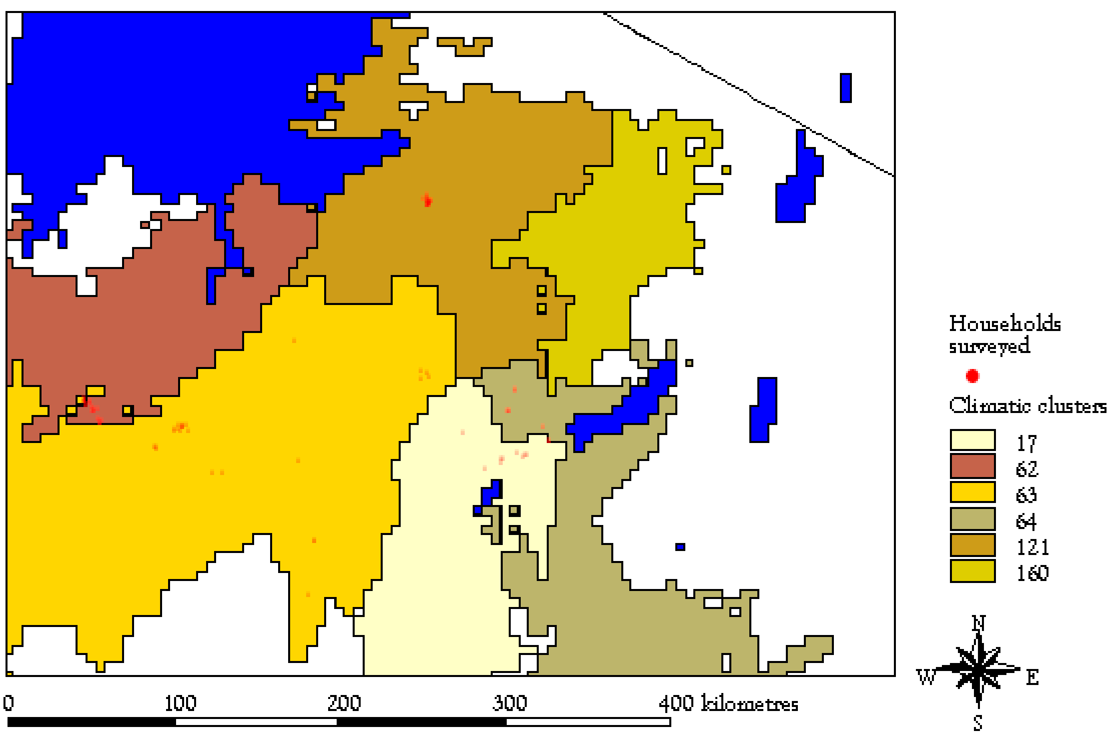
Map 3. *Climatic clusters and households surveyed in southern Kenya.*



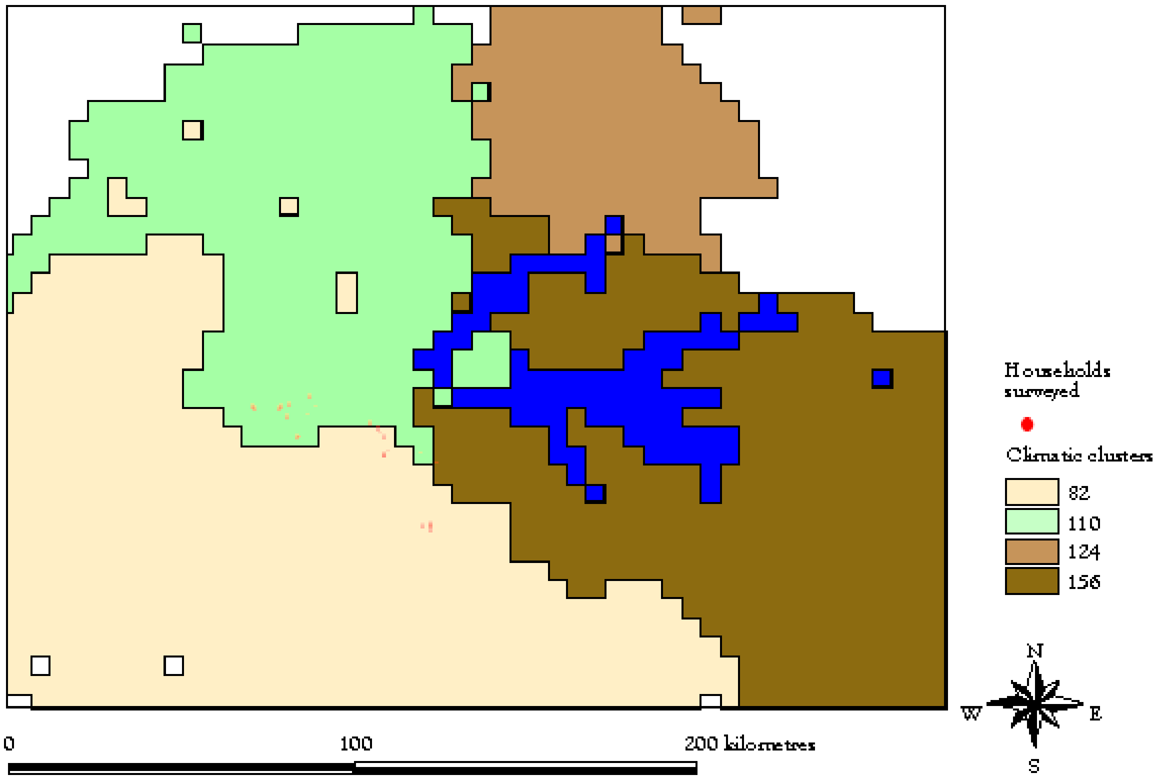
Map 4. *Climatic clusters and households surveyed in northern Tanzania.*



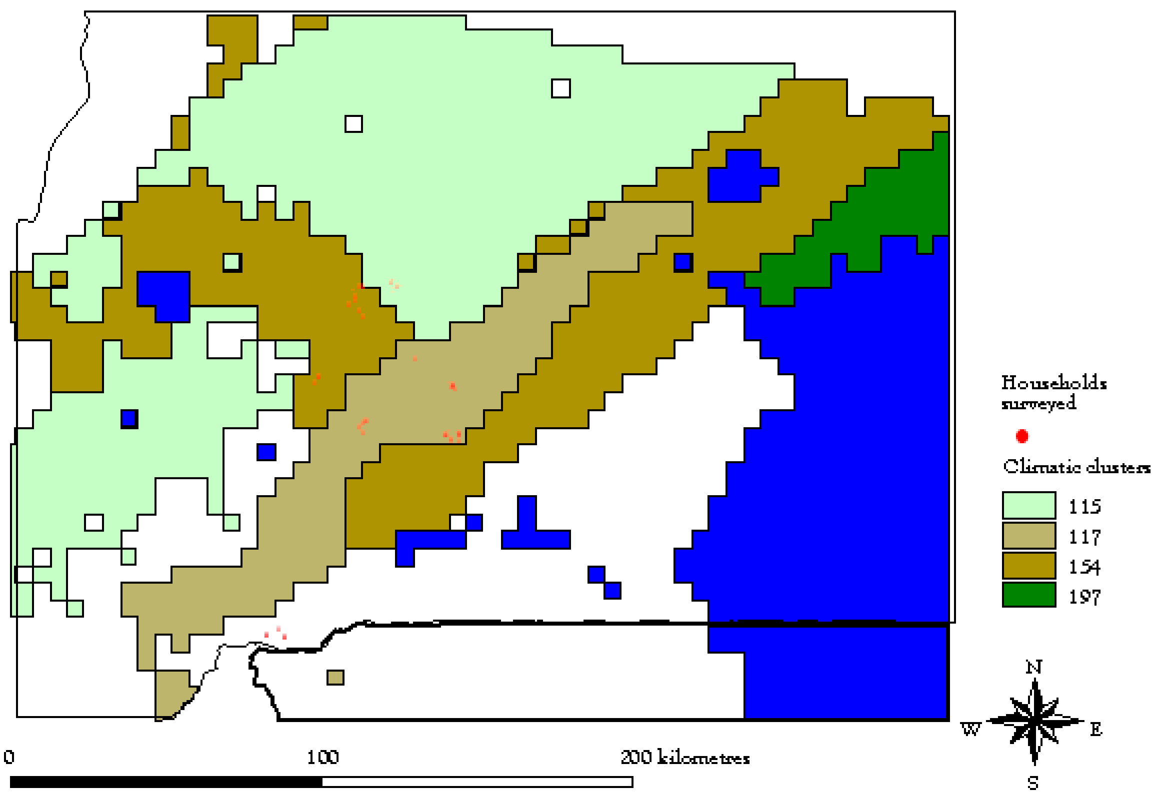
Map 5. *Climatic clusters and households surveyed in central Tanzania.*



Map 6. *Climatic clusters and households surveyed in north-western Tanzania.*



Map 7. *Climatic clusters and households surveyed in central Uganda.*



Map 8. *Climatic clusters and households surveyed in south-western Uganda.*

Appendix IV Abbreviations and acronyms

A-AARNET:	ASARECA-Animal Agriculture Research Network
AIDS:	Acquired immune deficiency syndrome
ASALs:	Arid and semi-arid lands
ASARECA:	Association for Strengthening Agriculture Research in East and Central Africa
CBPP:	Contagious bovine pleuro-pneumonia
CCD:	Cold cloud duration
CCPP:	Contagious caprine pleuro-pneumonia
CSIRO:	Commonwealth Scientific and Industrial Research Organization
DPIRP:	Drought Preparedness, Intervention and Recovery Programme
EARO:	Ethiopian Agriculture Research Organization
ENSO:	El Niño Southern Oscillation
EWS:	Early warning system
FAO:	Food and Agriculture Organization of the United Nations
FMD:	Foot-and-mouth disease
GHA:	Greater Horn of Africa
GL-CRSP:	Global Livestock-Collaborative Research Support Program
GPS:	Global positioning system
HIV:	Human immunodeficiency virus
IGADD:	Inter-Governmental Authority on Drought and Development
ILCA:	International Livestock Centre for Africa
ILRI:	International Livestock Research Institute
IPCC:	Intergovernmental Panel on Climate Change
KARI:	Kenya Agricultural Research Institute
KLDP:	Kenya Livestock Development Project
Ksh:	Kenya shilling
LEWS:	Livestock early warning system
LSD:	Least significant differences
NARO:	National Agriculture Research Organisation
NARS:	National agricultural research systems
NDVI:	Normalised difference vegetation index
NGO:	Non-governmental organisation
NIRS:	Near infra-red reflectance spectroscopy
OFDA:	Office of Foreign Disaster Assistance
PPR:	*Peste des petits ruminants*
SADC:	Southern Africa Development Community
SI:	Simpson index
SPLR:	Strengthening Partnerships for Livestock Research
SSA:	Sub-Saharan Africa
SST:	Sea surface temperatures
TAMU:	Texas A&M University
TLU:	Tropical livestock units
USAID:	United States Agency for International Development