

**AN APPRAISAL OF PASTORAL PRODUCTION POTENTIAL  
IN RELATION TO CONTINUED INTERVENTIONS BY THE  
ERETO NGORONGORO PASTORALIST PROJECT**

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## 1 INTRODUCTION

### 1.1 Project Achievements

The first phase of the ERETO project 1998-2002 has contributed to reducing poverty amongst the Maasai of the Ngorongoro Conservation Area through three interventions aimed at enhancing recovery of livestock production and pastoral livelihoods: restocking (*ewoloto*); improved access to water; and provision of veterinary services (Rowley, 2002).

#### 1.1.1 Restocking

Restocking began in 1999 and represents the largest commitment of staff time and project resources, with a budget of DKK11.5 million out of a total of some DKK30 million allocated to obtaining and distributing livestock to 3,400 Maasai families.

As of October 2002, 13,056 heifers and 12,876 shoats had been distributed to a total of 3,236 people, despite a severe drought in 2000, one of the worst in the past 30 years.

A further 656 heifers and 3,015 goats are to be distributed to the remaining 164 beneficiaries by the end of the current phase of the project. Restocked animals are estimated to be equivalent to about 7% of all livestock in the NCA.

To support and consolidate restocking programme, the project has also provided free veterinary assistance for two years and free distributions of maize for three years to recipient families, so that they were less likely to be compelled to sell livestock to survive and were, thus, better able to re-enter pastoral livestock production.

Mortality among restocked animals is reputed to have been comparable with that of pre-existing livestock, according to the people on *ewoloto* committees interviewed by the Review Preparation Team, but this has yet to be demonstrated from ERETO project data.

In assessing the impacts of restocking, it is important that comparisons be made with what would have occurred without project interventions and not with circumstances that prevailed before the project interventions. From experience elsewhere in eastern Africa, pastoral livestock populations are likely to recover to pre-drought levels over three to six years, given the support of animal health services<sup>1</sup>. ERETO's restocking programme is believed to have significantly reduced the population recovery time and the period of suffering for animal keepers has been dramatically shortened.

#### 1.1.2 Water Development

The provision of water has been another major project investment, covering a wide range of initiatives across the whole of the NCA. The various works were put out to tender and their implementation was overseen by the Water Environment and Groundwater Survey (WEGS) group, who were engaged as in-house consultants to provide expert technical advice to the project. Local communities established water committees and provided unskilled labour for some tasks and, for example, planting grass to stabilise earth banks on some dam constructions.

The impacts and effectiveness of water development have been considerable, including: increased quantities of water available; time saving by women; reduced distances to water for livestock; changed patterns of livestock movement; and improved functioning of schools and health clinics.

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<sup>1</sup> The variation depends upon the species concerned and recovery is much slower without veterinary inputs. DFID, Pastoral Livelihoods Programme Appraisal Final Report: Animal Health Service Delivery in Pastoral Areas of the Greater Horn of Africa, RWA International.

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Nevertheless, the Review Preparation Team has commented that the project could have done more to monitor the impacts of the water provision and the functioning of the water committees, which would have informed the design of other similar initiatives in future.

### **1.1.3 Provision of Veterinary Services**

The project's veterinary inputs are relevant and very highly appreciated by recipient communities and there is evidence of impact in terms of animal health and people's understanding of animal health problems and care. A considerable body of information about animal health in the NCA has been obtained and should provide a valuable resource for future monitoring purposes.

Two Private Veterinary Professionals (PVP) and six Animal Health Assistants (AHA) have received regular formal and informal training by veterinary consultants, the staff of Veterinary Information Centre (VIC), staff of the Tick and Tick-Borne Disease Control Project, AU-IBAR and various private consultants.

## **1.2 Objective of this Study**

The primary objective of this study was to provide a rapid and critical appraisal of the pastoral livestock production sector in northern Tanzania, based on a desk study of available reports and published literature.

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## 2 OVERVIEW OF PASTORAL LIVESTOCK DEVELOPMENT<sup>2</sup>

### 2.1 Historical Perspective

International support for pastoral development in Africa has a long and somewhat chequered history, dating back to the mid sixties with the promotion of ranching and heavy capital investments in fencing, water development, and marketing and processing through parastatal companies in Kenya and across the Sahel. Few of these initiatives achieved their intended objectives and the importance of understanding the dynamics and complexity of pastoral livestock systems and producer responses began to be recognised. Subsequently, attention shifted during the late seventies and the early eighties to promoting pastoralist associations for range management and increasingly on the provision of other services for animal health care and water development. By the early nineties, it was felt that more holistic approaches, including consideration of options for arable farming, were needed, which led to increasing emphasis on community based natural resource management (Pratt et al., 1997; and de Haan, 1994).

Evaluations of the earlier phases of pastoral development initiatives were generally critical. Sandford (1985) emphasised: the lack of attention to organisation and management issues; the need to build coalitions with all stakeholders; excessive capitalisation; and the lack of attention to social aspects and prevailing land use; as major weaknesses. A second wide ranging investigation, which probably had the most profound effect on international support for pastoral development was that of the World Bank's Operations Evaluation Department (OED, 1985). This evaluation highlighted the low economic profitability of livestock development investments, because of insufficient attention to the incentive framework; inappropriate systems of land tenure; and the lack of capacity of implementing agencies, especially in the required interdisciplinary approaches. International support for livestock development in general and pastoral development in particular declined markedly during the nineties as a result.

### 2.2 New Concepts

During the same period that these critical evaluations of pastoral livestock projects were being made, five new concepts or paradigms of development emerged, which have greatly influenced the content and scope of subsequent pastoral development initiatives:

- *The high level of efficiency of traditional pastoral production systems.* The ground breaking work of Breman and de Wit (1983), which showed that the production of animal protein per hectare in the Sahel was two to three times higher than that of areas with similar climate and soils in Texas and Australia, implied that the potential for large incremental benefits from pastoral production systems was very limited. These findings have led to a more general awareness that pastoral production systems are not as antiquated and backward than had previously been widely assumed. As a consequence, the high incremental benefits, projected by many development planners in the early phases of pastoral development, were overly optimistic, or even unrealistic.
- *The non-equilibrium nature of pastoral production in arid environments.* The work by Ellis and Swift (1988), followed by Behnke et al. (1993), which showed that under most arid conditions, the vegetation at any given time was more the result of previous climatic conditions than of previous grazing pressure, also greatly affected thinking on the potential of pastoral development. This work provided the basis for "opportunistic management" and challenged previous efforts to regulate stocking rates. Its focus on mobility in stock management and flexibility in grazing pressure adjustment, contributed to a significant change in direction in pastoral projects in eastern and southern Africa, where ranch development had been most

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<sup>2</sup> Adapted from: de Haan (1999). Future challenges to international funding agencies in pastoral development. VI International Rangelands Conference, Townsville, Australia.

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pronounced. The non-equilibrium work explained the remarkable resilience of arid rangelands, although Pratt et al. (1997) subsequently stressed the limitations of opportunistic management under conditions of uniform landscapes without key resources sites, and where range condition remained in a still near natural state.

- *The much stronger emphasis given to understanding existing pastoral systems, prior to initiation of development activities.* Over time, a growing awareness of the complexity of pastoral systems and the wide diversity of pastoral objectives has emerged. Driven by the political objectives of providing cheap meat to urban areas, earlier range-livestock development concentrated on increasing the meat output from pastoral systems. As this was often contrary to the objectives of the pastoral population, adoption of those technologies to promote increased meat offtake generally failed. Understanding the production objectives of a particular pastoral communities, i.e. whether they are mostly trade or mostly subsistence oriented (Pratt et al., 1997), is obviously of critical importance to determining the economic feasibility and sustainability of any potential development initiative.
- *A much sharper distinction regarding public and private sector roles in development.* Donor driven structural adjustment, fiscal austerity and decentralisation has resulted in major reductions in public involvement in productive and commercial activities. Nowadays, public sector interventions can increasingly only be justified where there is a significant market failure or externality and/or social inequity. It is important to recognise that this increased emphasis on international funding for public sector roles, in principle at least, benefits pastoralists, as pastoral production usually occurs on communal areas, often focuses on marginal populations, and produces important environmental goods and services, such as biodiversity conservation and watershed management.
- *The strong move towards decentralisation and local empowerment.* There is now substantial evidence to indicate that decentralised and community based approaches to natural resource management lead to a greater share of the resources reaching the intended beneficiaries, and to enhance sustainability when outside support is phased out. Future emphasis should, therefore be on strengthening local governments and local land user groups, and village committees in land management.

### **2.3 Future Challenges**

With widespread urbanisation of human populations, demand for meat and milk is expected to increase dramatically in the developing world over the next twenty years. The International Food Policy Research Institute projects that demand for meat and milk in the developing world will increase by 2.8% and 3.3% respectively per year until 2020 (Delgado et al., 1999). The potential of pastoral production systems to satisfy this increasing demand, is limited. Globally, over the last decade, off-take from grazing systems has increased by only 0.4% per year, and no further increase is expected, certainly not from the arid zones (de Haan et al., 1997). Pastoral development should, therefore, be guided by social and environmental objectives, and the focus should be on preservation of environmental goods and human welfare. Key future challenges in pastoral development within this perspective are likely to be:

- *To achieve a better incorporation of pastoral peoples in the consultative process and sustainability of pastoral institutions.* Urban dwellers and crop farmers are often better represented in discussions on land use rights and access to other resources than the mobile and remote pastoral producers (Waters-Bayer and Bayer, 1994). Moreover, globally there is clearly a declining social cohesion at the higher level of traditional pastoral organisations, as traditional institutions and discipline are eroding. This fragmentation has weakened the input of the pastoral sector in consultative processes and is probably also one of the main reasons behind the limited sustainability of pastoral organisations. Key constraints in the sustainability of pastoral institutions relate to: the lack of support at the national level because of government

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apprehension of herder empowerment: the confusion between social and commercial activities in many associations (and donor perceptions); and the short time span allocated by project activities to pastoral institution building.

- *To maintain adequate access to land and water.* Increased population pressure leads to increasing encroachment of crop farming into higher potential zones of arid lands (e.g. highlands receiving greater rainfall, river valleys, run-on areas) previously used, more or less exclusive, for dry-season grazing. In any given area, such encroachment can undermine the viability of the entire pastoral system. This is exacerbated by past land titling projects, for example in Kenya and southern Africa, which promote individual titling over communal areas and can result in range degradation. A concerted effort to preserve or restore such critical higher potential areas for pastoral production is a major challenge for the future. Creating greater awareness amongst decision maker regarding the special resource access features of mobility and flexibility that the pastoral systems require is a critical challenge for the pastoral development community.
- *To develop appropriate drought preparedness strategies.* Drought is an overriding attribute of environmental degradation and social upheaval in arid pastoral systems. There is now a good body of knowledge on pre-drought early warning systems, food aid programs during drought, and post drought re-stocking work. However, there is still little knowledge on how to increase the indigenous resilience of pastoral populations to drought. Government and international donor assistance often still includes the provision of free concentrate, thereby undermining the non-equilibrium principles of pastoral systems. Finding ways to de-stock rapidly when droughts are imminent, and re-stock when rains appear, even if it requires subsidy, may be less costly and cause less human suffering, than the classical food aid and other emergency operations. Drought preparedness is still a major gap in pastoral development. Food aid programs must also take into account the need for pastoral mobility in organizing food delivery networks.
- *To diversify income and employment.* The potential to increase meat, hide and wool production and income from arid range lands is limited. Policies aiming at achieving economic sustainability of pastoral production should, therefore, have employment generation outside the pastoral sector as a key component. Unless a substantial part of the growing human population finds full or part-time employment outside the pastoral sector, it will be difficult to provide acceptable income levels to all. The search for alternative employment should be combined with more attention to diversification of rangeland production. Alternative plant products (resins, medicinal plants) and agro-eco-tourism (especially if integrated with wildlife tourism) can be important sources of income. The latter is already an important income-earner on many ranches in the developed world (Walker, 1996), and by some is seen as surpassing beef production as the main income generator over the next decade. Possibilities might also be explored for the payment to pastoralists for the ecological services, such as biodiversity conservation and carbon-sequestration that rangelands can provide. For both services, the design of appropriate benefit sharing and monitoring mechanisms is crucial for their eventual success.
- *To continue to ensure adequate access to key services.* The introduction of appropriate veterinary, water management and other services for pastoralists in low-density and marginal areas has received considerable attention from international donors, as well as Non Government Organisations. Most interventions have relied on para-professionals and user groups, working on a private basis. While some good results have been achieved, the sustainability of these systems is still uncertain, and more needs to be done, to integrate those systems in the private and public professional systems. In addition, little has been done to prepare specific education programs for mobile pastoralists, although this is also a key requirement to ensure a better integration of these populations in the consultative process.

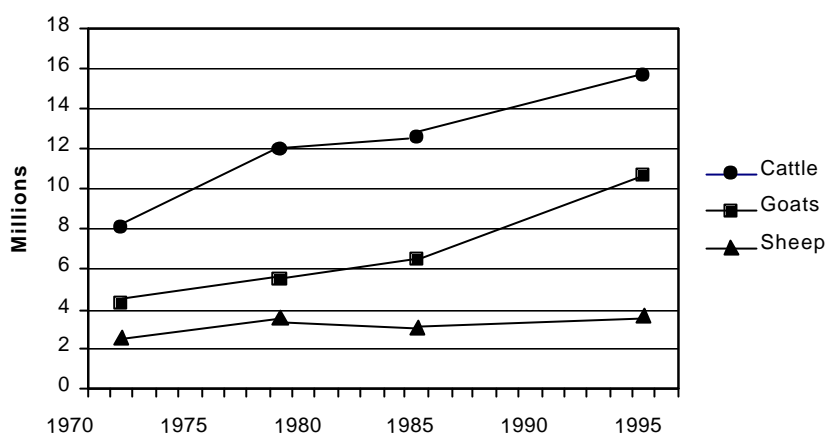
### 3 REVIEW OF PASTORAL LIVESTOCK RESOURCES, ANIMAL DISEASES AND MARKETTING IN THE NCA

#### 3.1 Population Trends

##### 3.1.1 National and Regional Perspectives

Periodic surveys of Tanzania's livestock resources have been conducted as part of national sample censuses of agriculture in 1971, 1978, 1984 and 1995 (GoT, 1994 and 1996) and indicate that cattle and goat populations have increased progressively and doubled over the past three decades, whilst the sheep population has remained relatively stable, as shown in Figure 1.

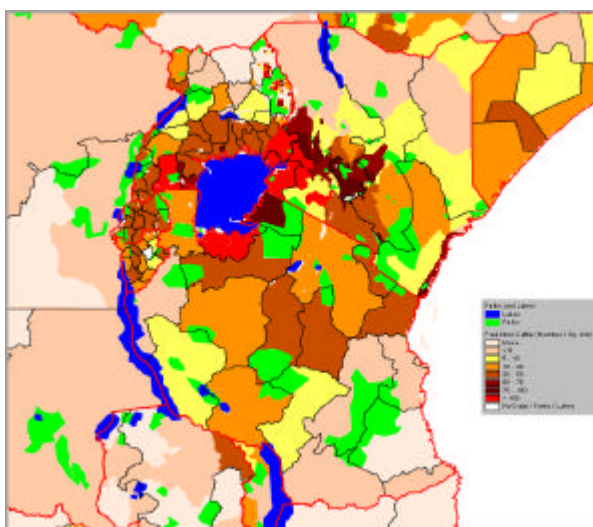
Figure 1: Tanzanian Livestock Population Estimates



Sources: (GoT, 1994; GoT, 1996)

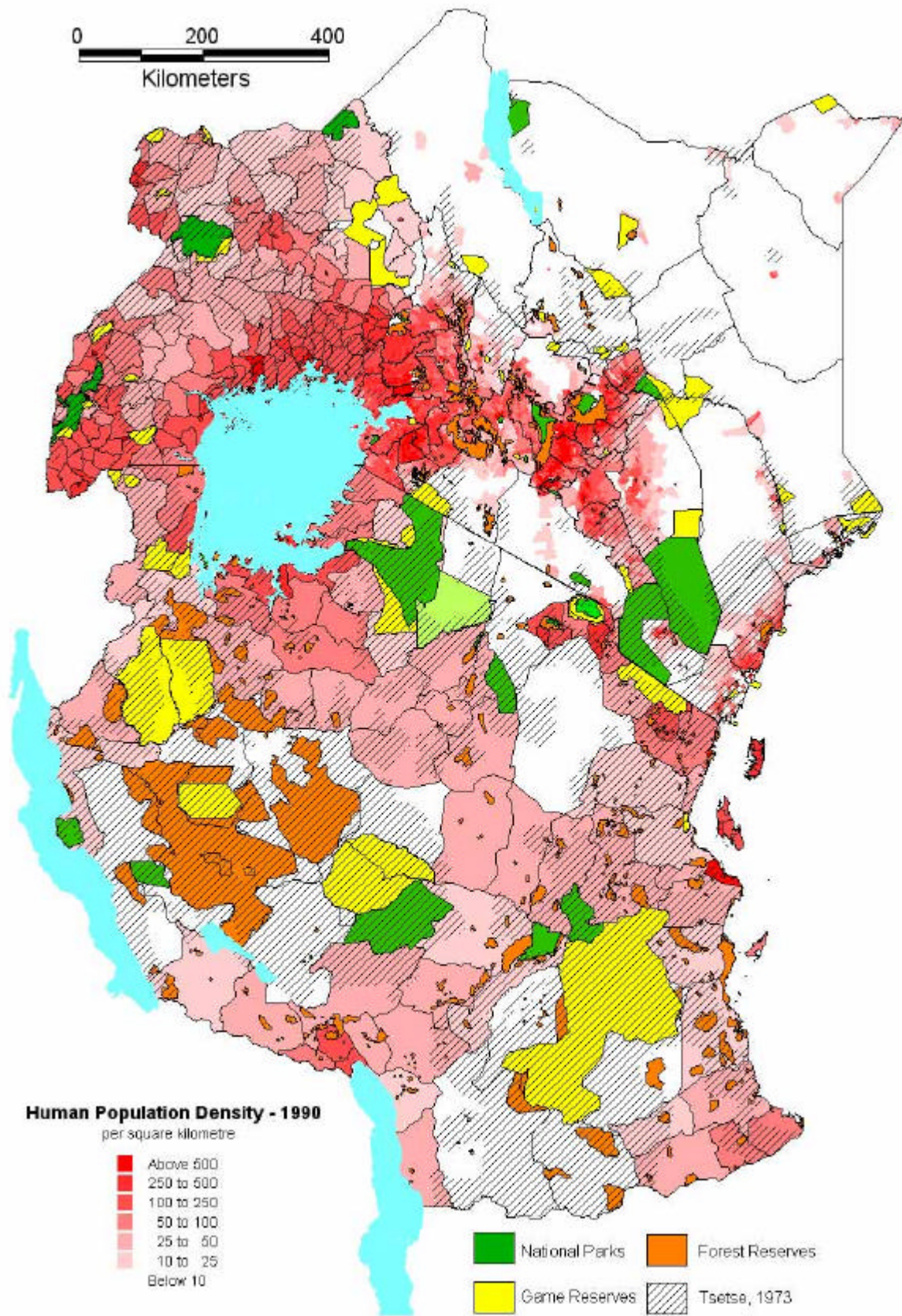
How representative these figures are of transhumant pastoral populations is a matter of conjecture, but, nevertheless, available information indicates that cattle numbers have increased from 8 to 15.6 million; goats from 4.3 to 10.7 million; and sheep have fluctuated between 2.6 and 3.7 million. Highest recorded densities of cattle in Tanzania occurring in Mara, Mwanza, Shinyanga, Singida, Dodoma and Tanga regions. Regional distributions of cattle, people, protected areas, tsetse and livestock production systems in eastern Africa are shown in Figure 2, Figure 3 and Figure 4.

Figure 2: East African Cattle Distribution in the 1990s



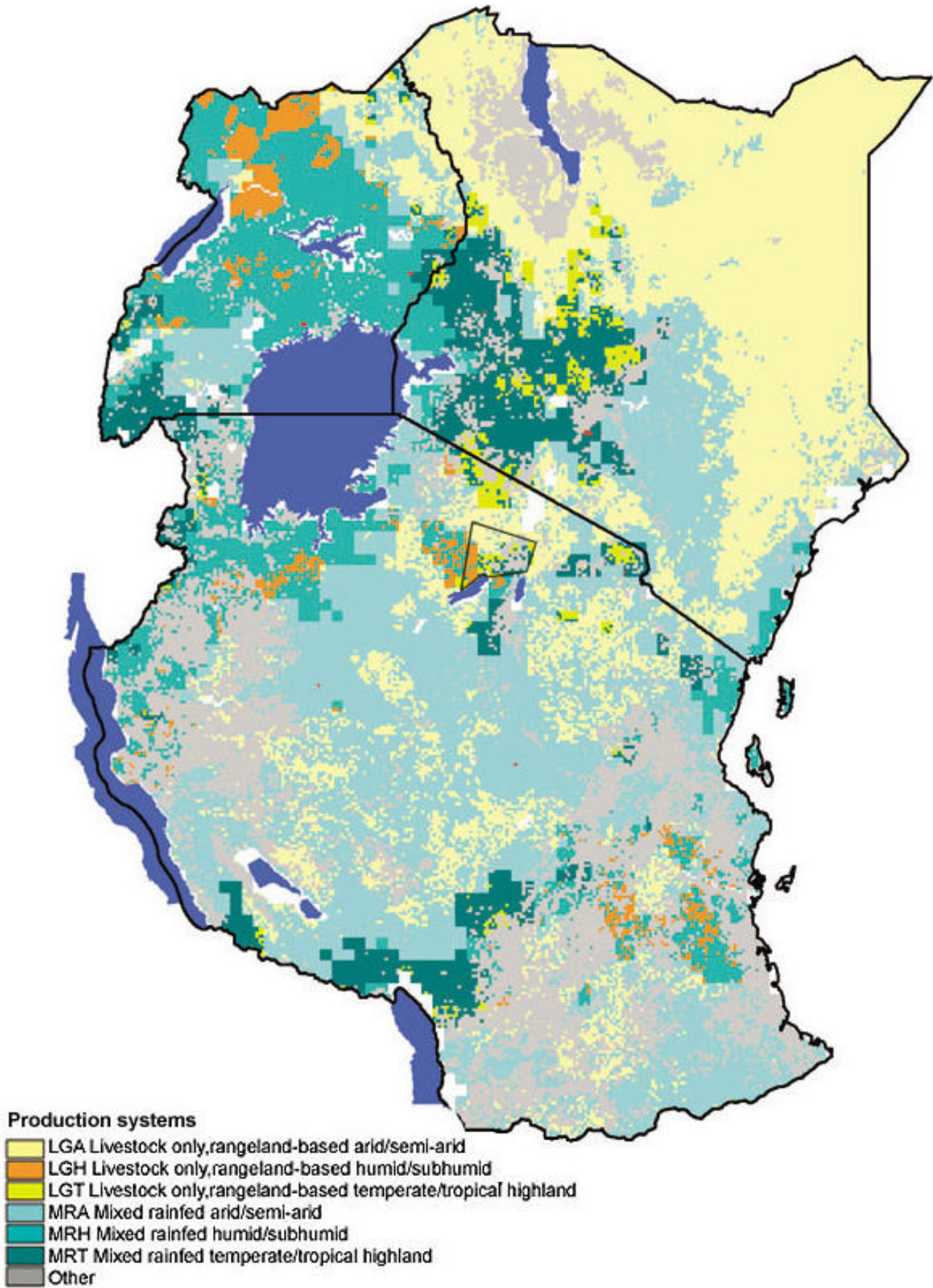
Source: (FAO, 1999) derived from National Livestock Census Data

Figure 3: People, Protected Areas and Tsetse in East Africa



Source: Bourn and Blench (1999), derived from Campbell (pers. comm.) and FAO (1999).

Figure 4: Livestock Production Systems in East Africa



Source: Thornton et al. (2002).

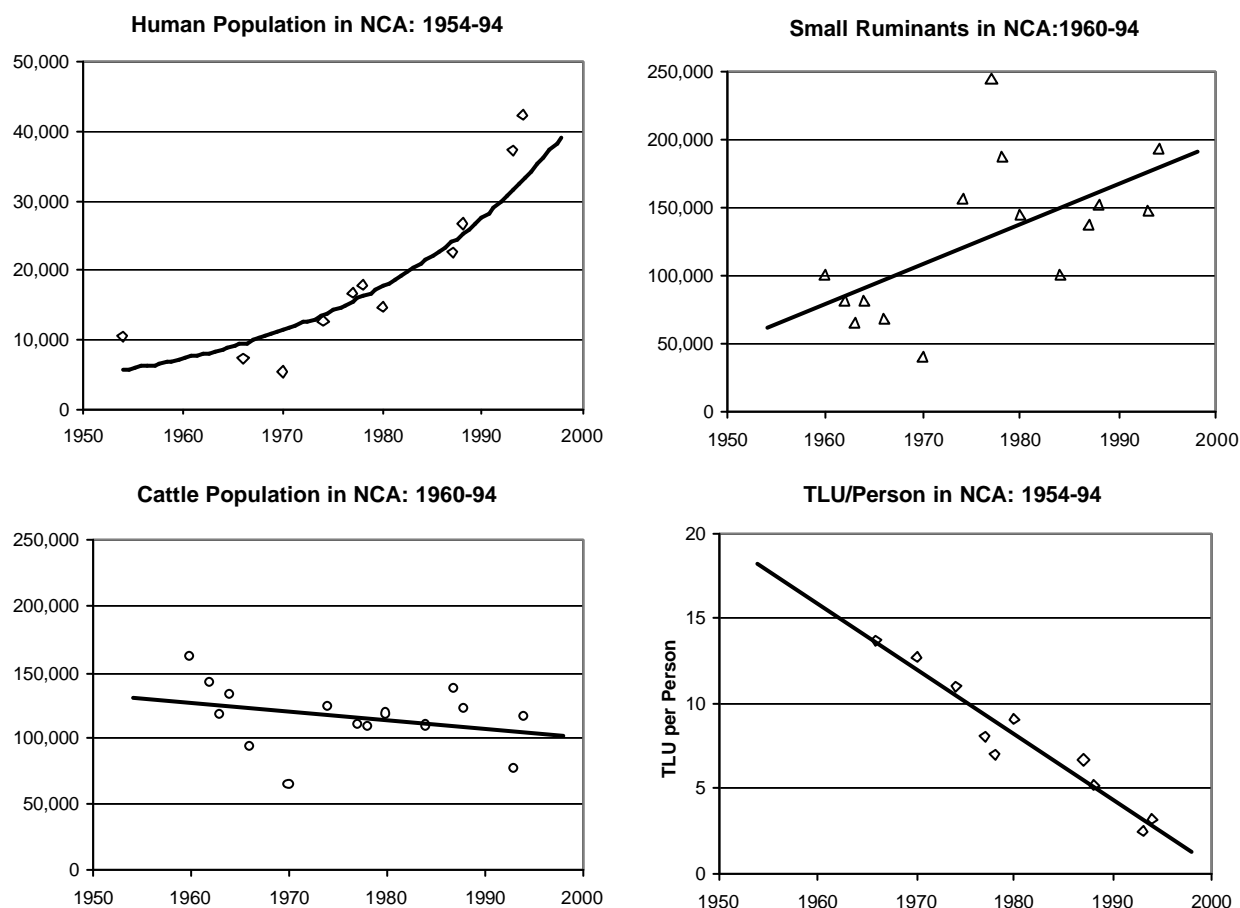
Figure 4 is based on a global classification of livestock production systems devised by the International Livestock Research Institute (ILRI) and the Food and Agriculture Organisation (FAO) (Thornton et al., 2002), and indicates the distribution of the six major systems found in East Africa defined in the legend of the figure. Five of the six systems are shown to occur in the NCA, reflecting the variety of environmental and climatic conditions, rather than any great diversity in the modes of production, which remains predominantly one of pastoral transhumance over extensive rangelands, with some small-scale cultivation around semi-permanent homesteads, as described by Homewood and Rogers (1987 and 1991); and Potkanski (1997).

### 3.1.2 Ngorongoro Conservation Area

Livestock population estimates for the Ngorongoro Conservation Area (NCA) have varied considerable from year to year, but long-term records and indicative populations trends are shown in Figure 5. The resident Maasai human population (top left) declined during the sixties, but has increased progressively since the early seventies. Livestock numbers followed a similar pattern, declining during the sixties and recovering during the seventies. Whereas cattle (bottom left) outnumbered small ruminants (top right) during the sixties, small ruminants have predominated numerically since 1970.

The net result has been a very substantial decrease in the ratio of livestock to people from almost 14 to about 3 Tropical Livestock Units (TLU) per person (bottom right). This catastrophic decline has, unsurprisingly perhaps, coincided with increasing levels of poverty and an expansion of small-scale cultivation within the NCA, as shown in Figure 6.

Figure 5: Population Trends in the Ngorongoro Conservation Area



TLU=Tropical Livestock Unit, equivalent to 1 bovine, or 10 small ruminant

Sources: Derived from: Homewood and Rogers (1991), Thompson 1997) and Bourn and Blench (1999)

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It is important to recognise, however, that most of the agricultural expansion in this region has been of a relatively large-scale commercial nature on the south-eastern slopes of the Ngorongoro highlands, outside the NCA, (Figure 6) where rainfall is higher and more reliable.

In future, wildlife populations are likely to be increasingly concentrated in and around protected areas, particularly in the drier and less densely populated semi-arid zone, including: Serengeti, Ngorongoro, Manyara and Tarangire. Many of these peripheral areas adjoining Tanzania's national parks and game reserves are designated, somewhat ambiguously, as Game Controlled Areas (GCAs).

Settlement, farming and hunting are all permitted in GCAs. Many have been extensively cultivated and little wildlife remains. The prospects for sustainable co-existence of livestock and wildlife in GCAs with arable potential is, therefore, somewhat limited, as has been the case in higher rainfall areas immediately to the north of the Maasai Mara in Kenya, where there has been a substantial increase in large scale commercial farming over the past two decades (Homewood et al., 2001).

**Figure 6: Extent of Cultivation in Ngorongoro Conservation Area**

Cultivation is indicated in black in this interpretation of LANDSAT imagery from February 2000.



Source: GL-CRSP (2002)

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## 3.2 Disease Risks Associated with Livestock and Wildlife Co-existence<sup>3</sup>

### 3.2.1 Pastoralists' Strategies for Limiting Disease Risks

Mobility and the maintenance of good physical condition are key elements of animal disease control. The ability of pastoralists to track the seasonal availability of resources is of fundamental importance in determining the nutritional status and the capacity of animals to resist and overcome infection. Mobility also enables pastoralists to manage disease risk by avoiding known areas of risk and vector infestation, or, at least, minimising the period of contact (Roderick et al., 1998).

Disease avoidance strategies, however, are not always successful. A wealth of ethno-veterinary knowledge exists and a variety of traditional remedies are in common usage (ITK/IIRR, 1996; Wanyama, 1997; Brightwell et al., 1998). Where available, manufactured veterinary products are also widely used, including antibiotics, trypanocides and anthelmintics, although these are not always applied according to manufacturer's recommendations.

### 3.2.2 Changing Circumstances

In assessing the disease risks associated with livestock and wildlife co-existence, it is important to recognise that pastoral conditions in East Africa are changing, and that pastoralism is in a state of transition. A review of livestock development in the Ngorongoro Conservation Area (NCA) in Tanzania (Field et al., 1988) drew the following conclusions:

- Since 1966 there had been a three-fold increase in human population, without a corresponding increase in livestock numbers;
- The incidence of some diseases had increased and 'new' diseases had entered the area, some with devastating consequences e.g. East Coast Fever – 'olmilo', Malignant Catarrhal Fever, Foot and Mouth Disease, Nairobi Sheep Disease and Contagious Bovine Pleuropneumonia;
- Livestock health services had deteriorated, dips had broken down and it had become more and more difficult for livestock owners to obtain acaricides and veterinary drugs;
- Infrastructure, particularly water supplies and roads, had deteriorated;
- Wildlife in general, and wildebeest in particular, had increased in number, and livestock owners blamed this for the increase in livestock diseases;
- Herd size had decreased because of disease and stock had to be sold to buy food.

Whilst the changes observed in the NCA may apply to some other areas, they are not necessarily representative of pastoral conditions throughout East Africa. There have, for example, been significant declines in wildlife populations outside protected areas in Kenya over the past two decades (GoK 1995a&b, 1996), and the risk of disease spreading from wildlife to livestock in these regions has diminished. With the decline in wildlife and the expansion of agriculture, tsetse numbers have been reduced in some areas and trypanosomosis is no longer such an important disease. Nevertheless, tsetse will persist wherever wildlife survives and suitable habitats exist and trypanosomosis will remain a serious constraint to livestock production in such areas for the foreseeable future.

Over the years, pastoral mobility has been reduced in many areas by the conversion of extensive areas of rangeland to farmland, and by the general tendency towards more sedentary life styles. Thus pastoralists, who would previously have moved their cattle to avoid a seasonal risk of disease, may be unable to do so once settled. Livestock of settled pastoralists in some areas may,

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<sup>3</sup> Based on Stevenson in: Bourn and Blench, (eds), (1999).

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therefore, be exposed to the virus that causes Malignant Catarrhal Fever (MCF) when wildebeest are calving; or the risk of trypanosomosis when tsetse increase and spread after the rains.

The control of animal diseases in East Africa has suffered from major financial constraints for many years, and government veterinary services in many rural areas have collapsed, especially in the remoter rangelands. On the other hand, improved methods for controlling animal diseases and disease vectors have been developed. Examples include: pour-on insecticides for the control of tsetse and trypanosomosis; and immunisation against East Coast Fever. Alternative forms of private sector and non-governmental animal health care delivery are also emerging. On balance, however, with the decline in veterinary services, reduced drug availability and resurgence of previously controlled diseases, livestock producers in the semi-arid rangelands of East Africa are facing increasingly severe disease problems.

### **3.2.3 *Animal Diseases of General Concern in Pastoral East Africa***

Many diseases have the potential to affect both wildlife and livestock in East Africa (OAU/STRC/IBAR 1986; Grootenhuis, 1995). Whenever wild and domestic animals share the same environment, there is always a risk of disease transmission from one to the other, but how serious that risk is very much depends on specific circumstances. Some diseases are uncommon, or are rarely recognised; some are common, but have little impact. Relatively few animal diseases are considered to be of major economic importance. The main diseases associated with livestock and wildlife co-existence in East Africa are characterised in Table 1.

The resurgence of livestock diseases that were formerly controlled, or restricted to certain areas, is an obvious cause for concern. One such disease is Contagious Bovine Pleuropneumonia (CBPP), which is on the increase in many parts of East Africa (Masiga et al., 1996). Previously the disease had been confined to the north of Kenya, but is now widespread. Symptoms are severe and mortality rates are high in herds with no previous exposure. CBPP is considered to be one of the most important disease problems facing veterinary authorities in Kenya and Tanzania.

Another disease that has recently returned to areas where it had been controlled is trypanosomosis. In the past, the tsetse fly vector of the disease was effectively controlled in the Lake Victoria region of western Kenya, largely by the use of selective ground spraying of insecticides along the rivers and streams. In the 1970s, this region was considered to be free of tsetse, apart from some relatively small, defined areas, such as the Ruma National Park. In the last ten years, however, as tsetse control activities by the veterinary authorities have declined, the vector has re-established itself throughout much of the region. Tsetse infestation is now reported as far north as Bungoma District. Farmers have lost many cattle to trypanosomosis; a disease that had not been seen for so long that it had been largely forgotten, and was often not recognised when it reappeared.

**Table 1: Characteristics of Some Animal Diseases of Current Concern in East Africa**

<b>Disease</b>	<b>Type</b>	<b>Transmission Routes</b>	<b>Animals Affected</b>	<b>Control in Domestic Animals</b>
<b>African Malignant Catarrhal Fever</b>	Virus	Inhalation, or ingestion, of virus excreted by young wildebeest.	Cattle, wildebeest	Separation of cattle from calving and young wildebeest
<b>African Trypanosomosis</b>	Protozoa	Tsetse and, less importantly, other biting flies	Domestic livestock and man. Wildlife reservoir of infection	Trypanocides; vector control; trypanotolerant livestock
<b>Anthrax</b>	Bacterium	Ingestion of contaminated soil, food or water; inhalation; or through the skin	All mammals, especially herbivores	Vaccination; careful disposal of infected carcasses
<b>Bovine Cysticercosis</b>	Tapeworm	Ingestion	Cattle, rarely wild antelope (larval tapeworm). Man (adult tapeworm)	Meat inspection and thorough cooking
<b>Canine Distemper</b>	Virus	Inhalation of aerosol; or through contaminated objects	Domestic and wild dogs; lions and other carnivores	Vaccination
<b>Contagious Bovine Pleuropneumonia</b>	Bacterium	Inhalation of infective droplets from active, or carrier cases	Cattle, possibly buffalo	Vaccination, quarantine and removal of infected animals
<b>East Coast Fever, Corridor Disease</b>	Protozoa	Ticks	Cattle, buffalo	Tick control; immunisation and treatment method
<b>Foot and Mouth Disease</b>	Virus	Air-borne spread and inhalation, or ingestion, of infective material	All cloven-footed domestic and wild animals	Vaccination; quarantine; slaughter policy
<b>Rabies</b>	Virus	Bite from an infected animal	All warm-blooded animals, including man. Carnivores most important in spread	Vaccination; control of domestic dog population
<b>Rift Valley Fever</b>	Virus	Mosquito bite; inhalation of aerosol	Wide range of domestic and wild animals and man	Vaccination; vector control
<b>Rinderpest</b>	Virus	Close contact and inhalation of aerosol; or ingestion of contaminated feed	Domestic and wild ruminants; pigs	Vaccination and movement controls
<b>Tuberculosis</b>	Bacterium	Inhalation; ingestion	All domestic livestock, man and many wildlife species	Testing and slaughter policy

### 3.2.4 Animal Diseases of Current Concern in the Ngorongoro Conservation Area

The relative importance of animal diseases in the NCA, as judged by veterinarians practicing in the area and leaders of local pastoral communities, varies to some extent with locality, as summarised in Table 2 and Table 3 (Guiseppe, pers. com.) and illustrated in Figure 7 (Rwambo et al., 2000). East Coast Fever, Ormilo, CBPP, Foot and Mouth, Anaplasmosis, Heartwater and Trypanosomosis were amongst the common diseases reported in cattle, by both veterinarians and pastoral leaders. Endoparasites, Ormilo, Heartwater, Mange, Contagious Caprine Pleuro Pneumonia and Anthrax were the most commonly reported ailments of small ruminants.

**Table 2: Veterinary Practitioners' Animal Disease/Constraint Ranking**

<b>Endulen Practice</b>			
<b>Dr. Loomu Endulen</b>	<b>Mr. Sarmu Endulen</b>	<b>Mr. ole Munga Osinioni-Kakesio</b>	<b>Mr. Laisangai Olbalbal</b>
<b>Cattle</b>			
East Coast Fever	East Coast Fever	East Coast Fever	East Coast Fever
Ormilo	Ormilo	Ormilo	Ormilo – Heartwater*
Foot and Mouth Disease	CBPP	CBPP	Diarrhoea
CBPP	Foot and Mouth Disease	Anaplasmosis	Babesiosis
Babesiosis	Endoparasites	Malnutrition	Anaplasmosis
Poison (snake bites)	Trypanosomosis		MCF
<b>Sheep and Goats</b>			
Endoparasites	Endoparasites	Endoparasites	Diarrhoea/Worms
Contagious C.P.P.	Pneumonia	Ormilo	Ormilo – Heartwater*
Mange	Mange	Anthrax	Pneumonia
	Contagious C.P.P	Contagious C.P.P	Anthrax
		Mange	Brucellosis
			Pneumonia
<b>Makao Practice</b>			
<b>Dr. Ngowi Ngorongoro</b>	<b>Mr. ole Kisota Ngorongoro</b>	<b>Mr. Nambua Nayobi</b>	<b>Mr. Sirikwa Zephania Nainokanoka</b>
<b>Cattle</b>			
East Coast Fever	East Coast Fever	East Coast Fever	East Coast Fever
Ormilo	Ormilo	Heartwater – Ormilo*	Foot and Mouth Disease
CBPP	Foot and Mouth Disease	Anaplasmosis	Anaplasmosis
Trypanosomosis	Anaplasmosis	Trypanosomosis	Trypanosomosis
Babesiosis	Trypanosomosis	Plastic bags	Ormilo
Anaplasmosis	Haemorrhagic Septip.	Brucellosis	Babesiosis
Mange	Diarrhoea	Foot and Mouth Disease	Black quarter
Endoparasites	Babesiosis**	Endoparasites	Diarrhoea
Liver Fluke	CBPP		Pneumonia
<b>Sheep and Goats</b>			
Endoparasites	Diarrhoea	Endoparasites	Pneumonia
Abortions***	Mange	Mange	Diarrhoea
Mange	Heartwater - Ormilo	Diarrhoea	Anthrax
Pneumonia	Endoparasites	Heartwater – Ormilo	Endoparasites
Diarrhoea	Pneumonia	Mange****	Predators

\* Some confusion in differentiation between Ormilo and Heartwater, which are NOT the same.

\*\* In NPP cattle, only. \*\*\* Due to brucellosis and plant poisoning. \*\*\*\* Mainly in goats.

Source: Guiseppe, (pers. com.), based on information obtained from interviews.

**Table 3: Traditional Leaders' Animal Disease/Constraint Ranking**

Nainokanoka	Oloirobi	Kakesio	Oibalbal	Endulen
<b>Cattle</b>				
Heartwater	Ormilo/Heartwater	Ormilo/Heartwater	East Coast Fever	Ormilo/Heartwater
East Coast Fever	Heartwater	East Coast Fever	Ormilo	East Coast Fever
Anaplasmosis	East Coast Fever	Pneumonia	Anthrax	Anaplasmosis
Pneumonia (CBPP)	Pneumonia	Rinderpest	Pneumonia	Pneumonia
Trypanosomosis	Mange	Black quarter	Foot and Mouth	Foot and Mouth
Black quarter	Black quarter	Babesiosis	MCF.	MCF
Foot and Mouth	Babesiosis	Anaplasmosis	Anaplasmosis	Trypanosomosis
Babesiosis	Anaplasmosis	Udder abscesses	MCF	Babesiosis
Mange	*Nunuk	Foot and Mouth	*Nunuk	Black quarter
<b>Sheep and Goats</b>				
Pneumonia	Malnutrition	Heartwater	Anthrax	Diarrhoea
Haemorrhagic Sep	°Heartwater	Pneumonia	Pneumonia	***Ndigana
Eye disease	°Pneumonia	Lumpy Skin	Mange	Heartwater
Endoparasites	°°Bleeding nose	Diarrhoea	**Ndigana	Mange
Diarrhoea	Haemorrhagic Sep	***Eye disease	Lumpy Skin	**Eye disease
***Ndigana	Mange	Mange	**Eye disease	Pneumonia
Mange	Foot rot	***Ndigana	Foot rot	Foot rot

\* Three day sickness ?.

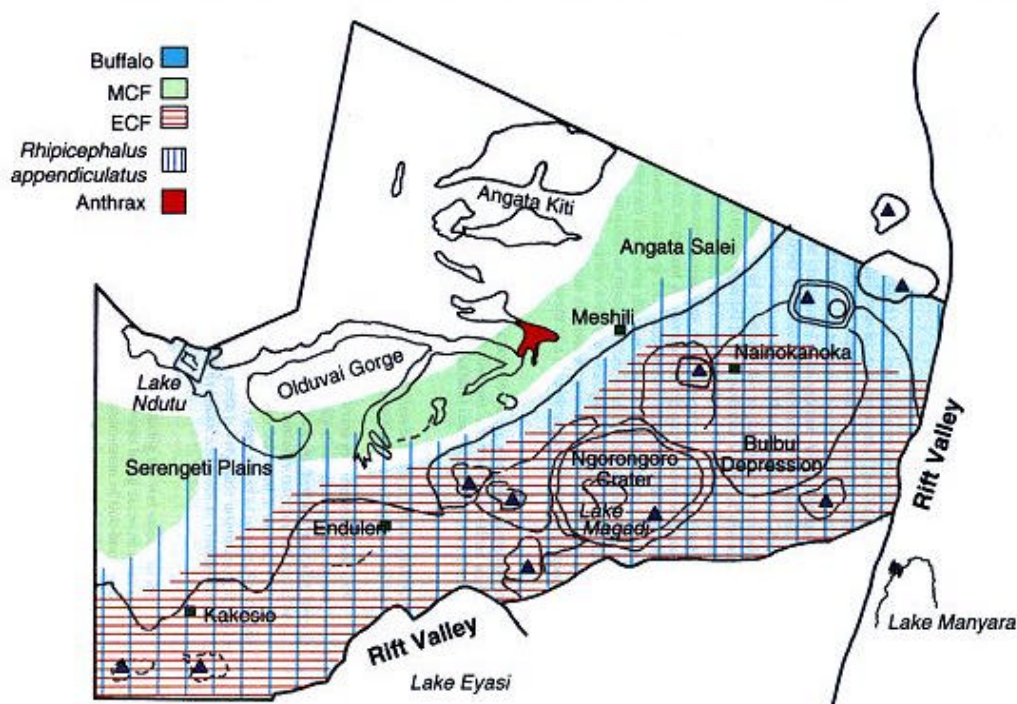
\*\* Disease similar to MCF. The disease (kerato-conjunctivitis (?)) is said to be appear in May-June in the period and in areas (lowlands) when Thompson gazelles calve.

\*\*\* Similar to East Coast Fever (the participants said it was due to *Theileria mutans*).

° Mainly in goats. °° Mainly in sheep.

Source: Guiseppe (pers.com.), based on information obtained at a Tick and Tick-Borne Diseases Control Seminar held in Makao (Ngorongoro-Oloirobi) in April 2000. First five diseases ranked in order of priority. NB Some confusion in differentiation between Ormilo and Heartwater, which are NOT the same.

**Figure 7: Animal Disease Risk Map of NCA**



Source: Rwambo et al. (2000)

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### **3.2.5 Disease Information and Monitoring**

Information concerning the occurrence, epidemiology and economic importance of most of the diseases common to both wildlife and domestic livestock in the rangelands of East Africa is fragmentary and of limited value. The need for accurate, reliable and up-to-date information on many of the diseases is widely recognised.

One disease where a more substantial amount of information and data has been collected is rinderpest. Through the PARC programme, co-ordinated from the OAU/IBAR office in Nairobi, it has been possible to build up comprehensive information on the occurrence of the disease. Collaborative links are maintained and encouraged with organisations involved in veterinary disease control and research in the region. Vaccine improvement and the development of easier and more convenient diagnostic tests are priority areas of research, but wider aspects of rinderpest control are also being investigated.

In contrast to the situation with rinderpest, very little is known of the true incidence of most other livestock diseases in the rangelands. Detailed information relating to specific areas is sometimes collected, but often as a result of a response to what is seen as an emergency or crisis situation. For instance, a substantial amount of data is now available on rabies and canine distemper in wild carnivores in the Serengeti and Mara from studies that were initiated following the devastating effects of epidemics of the diseases in the 1990s (Woodroffe et al., 1997; Cleaveland, 1998). With the lack of a properly functioning and reliable surveillance system for veterinary diseases in Kenya and Tanzania, prioritising diseases for research or control will continue to be dependent largely on limited information and informed guesswork.

It is for this reason that the information obtained by the Ereto project is of particular interest and considerable potential value. The data collected needs to be fully analysed with a view to providing a turn of the century assessment of animal health and pastoral livestock production within the NCA and baseline markers for future monitoring.

### **3.3 Livestock Production and Marketing**

Despite wide ranging social and economic change since Independence, livestock continue to play a central role in the livelihoods of the Ngorongoro Maasai, who remain largely dependant on livestock for almost all aspects of daily life: food; insurance against the risk of poor years; establishment and maintenance of social relationships; and for the generation of cash for purchases. Milk remains the preferred staple diet and transhumant pastoralism continues to be practiced by all but a few families (Field et al., 1988). With increasing human population and fluctuating livestock populations, however, the livestock to people ratio has declined from 13.7 TLU per person in 1966 to 3.2 TLU per person in 1994, as shown in Figure 5.

Given the prevailing local constraints, it is now generally recognised that pastoral production systems in Africa are relatively efficient and productive in terms of animal protein produced per unit area, compared with commercial ranching (Breman and de Wit, 1983; de Ridder and Wagener, 1986; Bekure et al. 1991; Homewood and Rogers, 1991; Behnke et al., 1993; and Roderick et al., 1998). The Ereto project is understood to have amassed a considerable body of information relating to animal health, restocking, herd recovery and livestock marketing in the NCA over the last three years, but this has yet to be analysed and documented, so unfortunately cannot be presented here. A brief account of previous studies is therefore outlined below, with the proviso that circumstances may have changed in the meantime.

Disease has long been considered a major constraint on livestock production. In their appraisal of livestock production and development potential in the NCA, Field et al. (1988) concluded that the performance of livestock was generally poor, with low milk yields, long calving intervals and slow population growth. Tick borne diseases were common and identified as the main reason for low productivity, with high calf mortalities, retarded growth and slow recruitment.

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Field et al. (1988) also reported that Endolen was the only official market then operating, but that with favourable exchange rates “there is a thriving black market in cattle trade to Ngong (Nairobi),” only 200 km to the north. As a result, “it was difficult to obtain precise statistics on livestock marketing when it is mostly operating in a clandestine manner.” Available information indicted that perhaps as much as 70% of offtake from the NCA at that time was exported through unofficial channels and sold in Kenya to supply Nairobi.

Continuing this line of argument, Homewood and Rogers (1991) suggested that “there are clear indications that the majority of NCA stock sales bypass the official system and have done so for 20 years, or more. There is a thriving cross border trade ..... to Kenya in exchange for 25-50% higher prices paid in hard currency, which can buy a wider range of goods at lower prices.” As Nairobi has by far the largest population in the region, it seems certain that it will continue to provide the main demand for meat in the foreseeable future, but demand from other urban centres, such as Arusha, Moshi, Dar-es-Salaam and Mombasa, is also likely to increase.

Recent simulation modelling studies have concluded that the provision of improved veterinary care within the NCA is likely to lead to an increase in livestock populations, unless additional animals can be disposed of through marketing (GL-CRSP, 2002). Further elucidation of the livestock trade and marketing in the region is, therefore, a subject of considerable importance that the Ereto project could most usefully report on, to provide a better understanding of: how the system operates; the extent of the trading network; the major centres of demand; and the number of animals traded.

The main livestock markets in the region include: Arusha, Kiteto and Mbulu in Tanzania and Namanga, Kajiado and Ngong across the border in Kajiado District of Kenya. Cattle from the NCA are sold for breeding throughout Tanzania and are sent for slaughter as far a field as Arusha, Dar-es-Salaam and Nairobi. The Maasai are well aware of price differentials between Kenyan and Tanzanian markets, and change the destination of trade cattle accordingly. Depending on market conditions, steers may be bought in Kenya, fattened in the NCA and then resold back in Kenya.

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## 4 REVIEW OF LIVESTOCK POLICY ENVIRONMENT

### 4.1 Government of Tanzania

#### 4.1.1 Poverty Reduction Strategy

According to Tanzania's Poverty Reduction Strategy Paper (PRSP): "Since independence in 1961, the Government of Tanzania has been preoccupied with three development problems: ignorance, disease and poverty. National efforts to tackle these problems were initially channelled through centrally directed, medium-term and long-term development plans, and resulted in a significant improvement in per capita income and access to education, health and other social services until the 1970s. Thereafter, these gains could not be sustained because of various domestic and external shocks, and policy weaknesses. Indeed, despite sustained efforts since the mid-1980s, to address the country's economic and social problems, one half of all Tanzanians today are considered to be basically poor, and approximately one-third live in abject poverty."

Source: [www.imf.org/External/NP/prsp/2001/tza/01/](http://www.imf.org/External/NP/prsp/2001/tza/01/)

Revealingly, if somewhat disturbingly, no mention is made of "livestock production," "pastoralism," "wildlife" or the "Ngorongoro Conservation Area" anywhere in the PRSP.

#### 4.1.2 IFPRI 2020 Vision of Livestock Sector Objectives

- To increase and maintain maximum sustainability of livestock production and productivity in order to enable the nation to achieve a per capita income and annual consumption of both meat, milk and eggs
- To increase livestock keepers income in order to improve their standard of living through increased production of livestock products, processing and marketing, both nationally and internationally
- To improve marketing infrastructure, income diversification, recognition and empowerment of pastoral institutions
- To supplement protein requirements of the rural and urban areas as well as to promote sport hunting, game viewing and trophies

#### 4.1.3 Livestock Policy

The stated aims of Tanzania's livestock policy are to promote the livestock industry so as to increase production and productivity to ensure that the nation achieves a per capita consumption of beef of 4.83 kg. per annum by the year 2005 (increase by 39%). This will enhance farmers' income, production of hides and exports of both live animals and other products.

Livestock policy in Tanzania is the subject of continuing debate, characterised by general confusion and uncertainty.

Primary administrative responsibility for livestock development in Tanzania now lies with the Ministry of Water and Livestock Development; but many aspects of pastoral life relate to various other ministries, including the Ministry of Agriculture and Food Security; the Ministry Community Development, Women and Children; Ministry of Lands and Human Settlements Development; and the Ministry of Natural Resources and Tourism.

#### 4.1.4 Strategies to Improve the Livestock Industry

- Private sector is encouraged to participate in promotion of community-based management of livestock infrastructure; grazing lands, dips and range development.

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- Strengthening extension services and research by both government and private sector participation.
  - Encourage the pastoral communities to form savings and credit institutions such as saving, and credit societies, trust funds and rural banks and work with pastoral communities and develop appropriate credit systems.
  - Establishment of livestock associations in the pastoral areas to enhance their bargaining and purchasing power in the supply of inputs, organizing the market of products and dissemination of new technology.
  - Private sector will be encouraged to participate in processing and export of livestock products and livestock surpluses.
  - Provision of marketing information by the government and on potential import markets.

#### **4.1.5 Environment Policy**

The overall objectives of Tanzania's environmental policy are to:

- Ensure sustainability, security and equitable use of resources for meeting the basic need of the present and future generations without degrading the environment or risking health or safety;
- Prevent and control degradation of land, water, vegetation and air, which constitute our life support systems;
- Conserve and enhance our natural and man-made heritage, including the biological diversity of the unique ecosystems of Tanzania;
- Improve the condition and productivity degraded areas including rural and urban settlements in order that all Tanzanians may live in safe, healthful, productive and aesthetically pleasing surroundings;
- Raise public awareness and understanding of the essential linkages between environment and development, and to promote individual and community participation in the environmental action;
- Promote international cooperation on the environment agenda, and expand our participation and contribution to relevant bilateral, sub-regional, regional, and global organizations and programs, including implementation of treaties.

Priority attention is being given to measures aimed at both conservation and management of the resources and environment, raising public awareness and understanding of the linkages between environment and their livelihoods, and promoting international co-operation on the environment agenda.

Source: <http://www.tanzania.go.tz/indexE.html>.

## **4.2 Ministry of Water Resources and Livestock Development**

The Livestock Department, formerly part of the Ministry of Agriculture and Cooperatives, is now a component of the Ministry of Water Resources and Livestock Development.

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The MWLD's vision/mission statement is: "To achieve a sustainable water resources and livestock development and management which is responsive to the needs, interests and priorities of the Tanzania population, both in rural and urban areas by the year 2025. To ensure that livestock and water resources management and development are carried out in collaboration with all stakeholders in an economic, environment and social sustainable manner."

The functions of the MWLD are to: coordinate water resources development policy, rural and urban water supplies, sewerage and drainage, drilling and dam constructions, water resources institute, central stores, central water laboratory, river basin development, water quality and pollution control, water boards, livestock development policy, livestock research and extension services, veterinary services, hides and skins.

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## 5 CONCLUSIONS

### 5.1 General Findings

Under inherently variable and unreliable climatic conditions, there are clear advantages for pastoralists to maintain an adaptive, transhumant mode of production and track available resources according to circumstances. Transhumant herds are managed in response to availability of fodder and water, and the risk of disease. When conditions are “good,” numbers increase; when conditions deteriorate, animals are moved, or are sold, or die, and numbers decline. Those with few assets to begin with are at greater risk of losing everything. Droughts affect some families more severely than others.

Available statistics for the NCA indicate that human population has increased progressively over the past four decades and that despite considerable inter-annual variation long-term trends have been for cattle numbers to decrease and small ruminants to increase (Figure 5). The net effect has been for livestock biomass (=wealth) per human to decline substantially.

With increasing international awareness of the relative efficiency of traditional pastoral production systems, there has been a major change of emphasis in the justification and purpose of pastoral development initiatives and how they have been implemented over the past decade or so.

The non-equilibrium nature of pastoral production systems in drylands, which drives transhumance and explains the remarkable resilience of sub-Saharan rangelands, is now more widely recognised. There is also a greater appreciation of the complexity of pastoral systems and the diversity of pastoral livelihoods. Understanding the production objectives of specific pastoral communities - whether they are primarily trade or subsistence oriented - is of critical importance to determining the economic feasibility and sustainability of any potential development initiative.

Donor driven structural adjustment, fiscal austerity and decentralisation has resulted in major reductions in public involvement in productive and commercial activities. Increasingly, public sector interventions can only be justified where there is a significant market failure or externality and/or social inequity. In principle at least, this should benefit pastoralists, as pastoral production usually occurs on communal areas, often focuses on marginal populations, and produces important environmental goods and services, such as biodiversity conservation and watershed management.

There is now substantial evidence to indicate that decentralised and community based approaches to natural resource management lead to a greater share of the resources reaching the intended beneficiaries, and to enhance sustainability when outside support is phased out. Future emphasis should, therefore be on strengthening local governments and local land user groups, and village committees in land management.

### 5.2 Issues

Key challenges for the enhancement of sustainable livelihoods in pastoral areas in general, as described in Section 2.3, include:

- How to achieve a better incorporation of pastoral peoples in the consultative process and sustainability of pastoral institutions?
- How to maintain adequate access to land and water?
- How develop appropriate drought preparedness strategies?
- How to diversify income and employment?
- How to continue to ensure adequate access to key services?

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### 5.3 Options

Given prevailing environmental conditions in the NCA and its designated status as a protected multiple use area, the options for any substantial increase in sustainable livestock production are very limited and relate to two main constraints: the availability of water and the risk of various animal diseases, both of which have been addressed by the Ereto Ngorongoro Pastoral Project.

The options available for diversification and enhancement of sustainable livelihoods and promoting food security in semi-arid pastoral areas in general are also limited, but the NCA, with its substantial number of visitors and tourist revenues, is exceptional and should have a greater variety of options than most.

The Joint Review should consider whether current project activities should continue as they are; be modified in some way; or drawn to conclusion and cease. They should also consider a variety of other options for intervention, including:

- Should the next phase of the project continue to focus on pastoralists within the NCA, or cast its net more widely?
- How can pastoral institutions be strengthened and pastoral communities empowered?
- Does the project's experience of restocking (*ewoloto*) and water committees warrant wider application?
- Are "early-warning" systems any use for de-stocking before drought and starvation?
- Would it be practical to establish a revolving fund to buffer the declining price of drought-induced sales against increasing price of livestock during post drought recovery?
- What is the most sustainable form of animal health care delivery system for pastoral areas?
- Should animal health care be provided as a public service, or by private practitioners, or by community based animal health workers, or a combination of these?
- Should animal health care be free, charged at a subsidised rate, or on full cost recovery basis?
- How can pastoral livelihoods be diversified and supplementary incomes be generated?
- How can education and training of pastoralists be improved and promoted?
- How can the health of pastoralists be improved?

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## REFERENCES AND DOCUMENTS CONSULTED

- Behnke, R. H., I. Scoones and C. Kerven, Eds. (1993). *Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savannas*. London: Overseas Development Institute, International Institute for Environment and Development and Commonwealth Secretariat.
- Bekure, S., et al., Eds. (1991). *The Maasai: an analysis of the livestock production system of Maasai pastoralists in eastern Kajiado District, Kenya*. Addis Ababa: International Livestock Centre for Africa.
- Bourn, D. and R. Blench (1999). *Can livestock and wildlife co-exist? An interdisciplinary approach. Livestock, wildlife and people in the semi-arid rangelands of eastern Africa*. London and Oxford: Overseas Development Institute and Environmental Research Group Oxford Limited.
- Breman, H. and C. T. de Wit (1983). "Rangeland productivity in the Sahel." *Science* **221**: 1341-1347.
- Brightwell, R., J. Kamanga and R. Dransfield (1998). *Key livestock diseases of dryland Kenya - a simple handbook for identifying and treating diseases of cows, sheep and goats on English and Kiswahili*. Nairobi: Kenya Economic Pastoralist Development Association.
- Campbell, K. and M. Borner (1995). Population trends and distribution of Serengeti herbivores: implications for management. *Serengeti II - dynamics, management and conservation of an ecosystem*. A. R. E. Sinclair and M. Norton-Griffiths. Chicago: Chicago University Press.
- Cleaveland, S. (1998). "Epidemiology and control of rabies. The growing problem of rabies in Africa." *Transactions of the Royal Society of Tropical Medicine and Hygiene* **92**: 131-134.
- de Haan, C. (1994). "An overview of the World Bank's involvement in pastoral development." *Pastoral Development Network. Paper No. 36b*. London: Overseas Development Institute.
- de Haan, C. (1999). Future challenges to international funding agencies in pastoral development: an overview. VI International Rangeland Conference, Session 20AMA: International Perspectives of Rangelands, Townsville, Australia.
- de Ridder, N. and W. K.T. (1986). "Energy and protein balances in traditional livestock systems and ranching in eastern Botswana." *Agricultural Systems* **20**(3): 1-16.
- Delgado, C., et al. (1999). *Livestock to 2020. The next food revolution*. Washington D.C.: International Food Policy Research Institute.
- Ellis, J. E. and D. M. Swift (1988). "Stability of African pastoral ecosystems, alternative paradigms and implications for development." *Journal of Range Management*, **41**(6): 458-9.
- FAO (1999). Programme Against African Trypanosomosis - Information System. Rome, Food and Agriculture Organisation of the United Nations.
- Field, C. R., G. Moll and C. Sonkoi ole (1988). Livestock development, Ngorongoro Conservation and Development Project, Technical Report Number: 1: pp37.
- GL-CRSP (2002). Integrated assessment results to support policy decisions in Ngorongoro Conservation Area, Tanzania. POLEYC Project (Policy Options for Livestock-based livelihoods, and EcosYstem Conservation). Davis, Global Livestock Collaborative Research Support Program, University of California: i-iiiv, 1-65.
- GoK (1995a). Kenyan rangelands 1977-1994: data summary report. Nairobi, Government of Kenya, Ministry of Planning and National Development, Department of Resource Surveys and Remote Sensing.
- GoK (1995b). Kenyan rangelands 1977-1994: summary of livestock data. Nairobi, Government of Kenya, Ministry of Planning and National Development, Department of Resource Surveys and Remote Sensing.
- GoK (1996). Kenyan rangelands 1977-1994: summary of population estimates for wildlife and livestock. Nairobi, Government of Kenya, Ministry of Planning and National Development, Department of Resource Surveys and Remote Sensing.
- GoT (1994). National sample census of agriculture 1994/95. Tanzania mainland. Volume 2: Household characteristics, livestock count, poultry, implements and storage. Dar-es-Salaam, Government of

---

Tanzania: Bureau of Statistics, Planning Commission, P.O. Box 796 and Statistics Unit, Ministry of Agriculture, P.O. Box 9192.

- GoT (1996). National sample census of agriculture 1994/95. Tanzania mainland. Volume 3: Holdings characteristics, livestock, poultry, agricultural practices and census evaluation. Dar-es-Salaam, Government of Tanzania: Bureau of Statistics, Planning Commission, P.O. Box 796 and Statistics Unit, Ministry of Agriculture, P.O. Box 9192.
- Grootenhuis, J. G. (1995). Wildlife utilisation study. Report 4: Veterinary. Nairobi, Conservation of Biodiverse Resource Areas Project: Kenya Wildlife Service and African Wildlife Foundation.
- Homewood, K. (1995). "Development, demarcation and ecological outcomes in Maasailand." *Africa* **65**(3).
- Homewood, K., et al. (2001). "Long-term changes in Serengeti-Mara wildebeest and land cover: Pastoralism, population, or policies?" *Proceeding of the National Academy of Sciences* **98**(22): 12544–12549.
- Homewood, K., W. A. Rodgers and K. Arhem (1987). "Ecology of pastoralism in Ngorongoro Conservation Area, Tanzania." *Journal of Agricultural Sciences* **108**: 47-72.
- Homewood, K. M. and W. A. Rodgers (1991). *Maasailand ecology: pastoralist development and wildlife conservation in Ngorongoro, Tanzania*. Cambridge: Cambridge University Press.
- ITK/IIRR (1996). *Ethno-veterinary medicine in Kenya - a field guide of traditional animal health care practices*. Nairobi: Intermediate Technology Kenya and International Institute of Rural Reconstruction.
- Malpas, R. and S. Perkin (1986). Towards a regional conservation strategy for the Serengeti, Dar-es-Salaam: Ministry of Natural Resources and Tourism and Nairobi: International Union for the Conservation of Nature and Natural Resources.
- Masiga, W., J. Domenech and R. S. Windsor (1996). "Manifestations and epidemiology of contagious bovine pleuropneumonia in Africa." *Revue Scientifique et Technique de l'Office International des Epizooties* **15**: 1238-1308.
- OAU/STRC/IBAR (1986). Wildlife/livestock interfaces on rangelands. Proceedings of a conference held at Taitia Hills Lodge, Kenya, 22-25 April 1985, Nairobi: Organisation of African Unity/ Scientific and Technical Research Commission/ Inter-African Bureau for Animal Resources.
- OED (1985). The smallholder dimension of livestock production - an evaluation. Washington D.C., Operations Evaluation Department, World Bank.
- Parkipuny, M. S. (1997). Pastoralism, conservation and development in the greater Serengeti region. *Multiple land use: the experience of the Ngorongoro Conservation Area, Tanzania*. D. M. Thompson. Gland, Switzerland and Cambridge, UK: Protected Area Programme, International Union for the Conservation of Nature: 143-169.
- Potkanski, T. (1997). *Pastoral economy, property rights and traditional mutual assistance mechanisms among the Ngorongoro and Salei Maasai of Tanzania*. London: International Institute for Environment and Development, Dryland Programme.
- Pratt, D. J., F. Le Gall and C. de Haan. (1997). Investing in pastoralism. World Bank Technical Paper No. 365. Washington D.C., World Bank.
- Roderick, S., et al. (1998). Livestock production in relation to seasonal grazing decisions and vegetation resource: a case study of a Maasai pastoralist system. Proceedings of an international conference on foods, lands and livelihoods, setting research agendas for animal science, Edinburgh, British Society for Animal Science and Kenya Agricultural Research Institute.
- Rowley, J. (2002). ERETO Ngorongoro Pastoralist Project: Review of lessons learned in Phase and issues to be considered in Phase II. Report to Danida. Hassocks, West Sussex, Information, Training and Development (ITAD Limited: pp31.
- Runyoro, V. A., et al. (1995). Long-term trends in the herbivore populations of the Ngorongoro crater, Tanzania. *Serengeti II - dynamics, management and conservation of an ecosystem*. A. R. E. Sinclair and M. Norton-Griffiths. Chicago: Chicago University Press.
- RWA, I. DFID pastoral livelihoods programme appraisal final report: Animal health service delivery in pastoral areas of the Greater Horn of Africa. Ripon, North Yorkshire.

- 
- Rwambo, P., et al. (2000). Assessment of wildlife and livestock disease interactions in the Ngorongoro Conservation Area of Tanzania. Boulder, Colorado State University, Natural Resource Ecology Laboratory, Integrated Management and Assessment System Project.
- Sandford, S. (1983). *Management of pastoral development in the Third World*. New-York: Wiley.
- Semboja, H., et al. (1998). Country Note for Tanzania. Kampala, Uganda, International Food Policy Research Institute, 2020 Vision Network for East Africa: pp26.
- Sinclair, A. R. E. and P. Arcese, Eds. (1995). *Serengeti II - dynamics, management and conservation of an ecosystem*. Chicago: University of Chicago Press.
- Sinclair, A. R. E. and M. Norton-Griffiths, Eds. (1979). *Serengeti: dynamics of an ecosystem*. Chicago: University of Chicago Press.
- Thompson, D. M., Ed. (1997). *Multiple land use: the experience of the Ngorongoro Conservation Area, Tanzania*. Gland, Switzerland and Cambridge, UK: Protected Area Programme, International Union for the Conservation of Nature.
- Thornton, P. K., et al. (2002). Mapping poverty and livestock in the developing world. Nairobi, Kenya, International Livestock Research Institute.
- Walker, B. H. (1996). Having or eating the rangeland cake: A developed world perspective on future options. Proceedings of the Fifth International Rangeland Congress, Salt Lake City, Utah, Society for Range Management, Denver, Colorado.
- Wanyama, J. B. (1997). *Confidently used ethno-veterinary knowledge in Samburu*. Nairobi: Intermediate Technology Kenya.
- Waters-Bayer, A. and W. Bayer (1994). *Planning with pastoralists: PRA and more. A review of methods focused on Africa*. Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).
- Woodroffe, R., et al. (1997). *The African wild dog - status survey and conservation action plan*. Gland, Switzerland: International Union for the Conservation of Nature.