



Executive Summary

**The Borana Plateau of
southern Ethiopia:**

**Synthesis of pastoral research,
development and change,
1980–91**

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INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA

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Executive Summary

The Borana Plateau of southern Ethiopia: Synthesis of pastoral research, development and change, 1980–91 summarises results from work conducted by 40 people in the southern Ethiopian rangelands between 1980 and 1991. The global objectives of this inter-disciplinary project were to describe the evolving production system of the Borana pastoralists and prescribe best-bet component interventions and policies that might promote growth in the livestock sector, alleviate poverty among pastoral producers and encourage ecologically sustainable patterns of resource use. A large effort was also devoted to contrasting our research results with other findings in the pastoral literature, largely from eastern and southern Africa. This comprehensive system study is intended to serve two main audiences: (1) professionals within Ethiopia who deal with range research and development and need detailed interpretation of local data but also have poor access to international literature and (2) an international audience concerned with more general implications of the work for pastoral research and development in sub-Saharan Africa.

Chapter 1: Review of rangelands and rangeland development in Ethiopia

The Ethiopian lowlands occur below 1500-m elevation and comprise 61% of the national land area. Climate in the lowlands includes arid (64%), semi-arid (21%) and subhumid (15%) zones largely defined by four rainfall and temperature regimes. These zones vary markedly in terms of number of plant growing days per year, forage production, common plant associations, livestock and human carrying capacities and incidence of important livestock diseases.

Ethiopia today has about 42 million people and over 70 million head of livestock. The lowlands are home to 12% of the human population (or five million people) and 26% of the livestock (or 21 million head). Land use by the 29 ethnic groups of the lowlands is dominated by various forms of pastoralism and agropastoralism. Livestock depend upon rangelands consisting of native vegetation, with crop residues increasing in importance as livestock feed as annual rainfall increases. Calculated for the lowlands overall, roughly six people/km² are dependent on 11 Tropical Livestock Units (TLUs), which are composed of cattle (49%), goats (16%), equines (16%), camels (12%) and sheep (7%). In contrast, the highlands support 72 people/km² dependent on 44 TLUs/km² which are dominated by cattle (76%), equines (14%), sheep (8%) and goats (2%). Thus, although the lowlands comprise over 50% more land area than the highlands, the lowlands have only 40% as many TLUs at one-quarter the density.

Although the lowlands have a lower abundance of animals than the highlands, the lowlands still play a crucial role in the national livestock economy. Livestock production is an important component of the national economy; in the mid-1980s livestock production comprised 33% of the gross value of annual agricultural output and 15% of gross domestic product. Besides supporting rural and urban lowlanders with milk, meat, employment and investment opportunities, lowland breeds of cattle and sheep made up over 90% of legal exports of live animals. In the mid-1980s, export revenues for live animals came in a distant second after coffee and comprised 12% of gross annual export revenue overall. However, about 450 000 head of lowland livestock may be traded on the international black market each year and official statistics often do not reflect this volume. This situation resulted from black market prices being 150% higher than regulated, domestic livestock prices during the 1980s. Lowland cattle may also provide around 20% of the draft animals for the highlands, particularly to the east, and smaller numbers are supplied for finishing on crop residues and cross-breeding in smallholder dairy programmes. The lowlands are thus an important source of livestock supply to the nation. This situation results, in part, because there are three times as many TLUs per person in the lowlands than in the highlands. This per capita "surplus" in the lowlands, however, may be declining because of rapid growth in the human population

(i.e. 2.1% per annum, with a doubling time of 26 years) and environmental limits on growth in livestock populations.

Although some development projects were targeted for lowland livestock systems in the 1950s, large-scale development efforts did not occur regularly until after 1965. These projects were generally intended to foster greater integration among lowland and highland production systems. The Third Livestock Development Project (TLDP), originally budgeted at US\$ 44 million, has been the dominant force in development of the pastoral livestock sector since 1975. The TLDP has provided infrastructural improvements (roads, markets, water) and support services (veterinary and facilitation of inter-regional trade) to around one million pastoralists residing in 27% of the lowlands to the north, south and east of the country. The primary goal was to stimulate livestock commercialisation. These regions were targeted because of proximity to national markets and infrastructure, the quality of indigenous livestock breeds and their higher ecological potential compared to other lowland areas. Despite chronic problems with regional security and the national economy, the TLDP has made a notable contribution, particularly in terms of infrastructure. As one of three sub-projects of TLDP, the Southern Rangelands Development Unit (SORDU) has been most successful in implementing programmes in the Borana pastoral system. In large measure this has been due to the enhanced security situation in the south during the 1980s compared with lowland development regions in the north and east.

More recent development initiatives have included the Pilot Project at SORDU in conjunction with the Fourth Livestock Development Project (FLDP) which was initiated in 1988 and the Southeast Rangelands Project (SERP) in the Ogaden, initiated in 1990. These projects were designed to incorporate participatory approaches to pastoral development in addition to provision of infrastructure and support services. Despite advances in pastoral development concepts since 1975, impact of pastoral development activities has been routinely constrained by shortages of operating funds and trained manpower and periods of insecurity.

Research and development organisations collaborated in the lowlands during 1982–90 to better understand the pastoral systems and design appropriate production interventions. These efforts included TLDP, ILCA, CARE-Ethiopia, the Institute of Agricultural Research and the Relief and Rehabilitation Commission (RRC) working in the SORDU sub-project area since 1985. Ultimately, the most effective approach involved research following the lead of insightful development agents who implemented a more participatory approach for identifying felt needs and production problems as perceived by the pastoralists. This evolved process appears to be a departure from traditional models of farming systems research and extension in which researchers take sole responsibility for problem identification.

Chapter 2: Introduction to the Borana Plateau: Natural resources and pastoral society

This chapter reviews secondary information on geology and sociology, as well as original information on climate, soils, wildlife, plant ecology and water resources for the central Borana Plateau. A 15 475-km² study area was selected because it represented an important region for the national livestock economy. Geology of the study area is dominated by quaternary deposits (40%), basement-complex formations (38%) and volcanics (20%). Except for a central mountain range and scattered volcanic cones and craters, the landscape is gently undulating across an elevation of 1000 to 1600 m. Vertisols occur more in valley bottoms while upland soils occur elsewhere. Valley bottoms are relatively scarce on the landscape and occupy about 12% of the study area. Vertisols appear higher in nutrient content and water storage capacity compared with upland soils.

The region is dominated by a semi-arid climate. Annual mean temperatures vary from 19 to 24°C with little seasonal variation and these decrease 1°C with each 200-m increase in elevation. Average annual rainfall for 10 sites during 1980–89 varied from 440 to 1100 mm (with an overall average of 700 mm) and this increased by 64 mm with each 100-m increase in elevation. The average of 700 mm is probably biased high because climate stations tend

to be located at higher elevations. Rainfall delivery is bimodal; 59% of the annual precipitation occurs during March to May and 27% in September to November.

A “dry” year is defined as one in which annual rainfall is <75% of average and may occur one year in five. The probability that two consecutive years will have average or above-average rainfall, one dry year, or two dry years is thus 0.64, 0.32 and 0.04, respectively. At least two consecutive dry years constitute a drought. In an average rainfall year the number of plant growing days ranges from 100 to 140 in the west and north of the study area, respectively, which corresponds to 1.5 to 2.0 t DM/ha/year of herbaceous forage production. Calculated throughout the study area, conservative calculations suggest that annual mean carrying capacity in an average rainfall year is 14 Tropical Livestock Units (TLUs)/km², or 217 000 head of cattle, but this can decrease to ≤10 TLUs/km² (or <155 000 head of cattle) in a dry year. Stocking rates for the near-average rainfall years of 1982–83 and 1988–90 suggest that mean animal density is commonly around 16 TLUs/km², or 250 000 head.

The region is dominated by savannah communities containing mixtures of perennial herbaceous and woody vegetation. Several native species of grasses and woody plants provide excellent forage. Forage nutritive value increases in rainy seasons compared to dry seasons and browse often retains higher nitrogen content in dry seasons compared to grasses. Elevation, with concomitant effects on temperature, precipitation and associated with shifts in soil parent materials, is the most important factor governing distribution of key plant species. In terms of fauna, the study area is home to at least 26 species of large wild mammals and 45 species of commonly observed birds.

The Borana Plateau is characterised by a general scarcity of surface water. There are over 540 hand-dug wells occurring in some 40 clusters largely to the west. These wells provide over 95% of the permanent water points and about 84% of the total accessible water in a typical dry season. The wells also provide about half of the annual water requirements for people and livestock, with the remainder provided by ephemeral and permanent ponds. Wells require large inputs of labour and are thus important in the social and economic life of Borana pastoralists. They also form the basis for traditional units of resource allocation called *madda*. There are about 35 *madda* with an average area of 500 km². Each *madda*, on average, may contain several well clusters serving some 100 encampments, 4000 people and 10 000 cattle.

The history of Borana society, its culture and resource allocation practices are reviewed. The Borana Plateau represents part of the remaining core area or cradleland of the southern highlands and rangelands from which the original Oromo culture expanded and conquered half of present-day Ethiopia during the 1500s. The core rangeland area contains historical Oromo shrines still worshipped by the population. The Borana territory has been reportedly shrinking since the early 1900s, largely because of induced habitat change and Somali encroachment from the east. The Borana social structure includes two moieties, five sub-moieties, 20 clans and some 60 lineages based primarily on patterns of male descent. Clans are widely distributed among *madda* and are the primary mechanism for wealth redistribution. Some 100 clan meetings are held each year in which the poor petition the wealthy for cattle. Political structure is related to the social structure. The Boran achieve consensus on important community issues through open, participatory assembly. Consensus and enforcement of social norms is achieved under the umbrella of the “Peace of the Boran”, which refers to traditional values and laws. Two peer-group structures for males, the age-set system (*Hariya*) and generation system (*Gada*) are discussed with respect to distribution of social rights and responsibilities and/or regulation of human reproduction.

These two systems share many similar attributes, but ultimately are complementary in function. All males have a position in each. *Hariya* consists of 10 eight-year blocks of similarly aged individuals between the ages of 12 to 91 who share a collective identity that evolves with ascension into subsequent age sets. The *Gada*, in contrast, consists of seven grades and an increasing number of generation classes that are created every eight years. *Gada* grades can contain males of vastly different ages. Among other attributes, the *Gada* grades confer political and ceremonial duties and subject members to different rules regarding sexual behaviour. It has been hypothesised that the *Gada* was created during the 1600s to help the society cope with a population explosion. Computer models have suggested

that *Gada* rules on reproduction served to reduce the population by 50% by the mid-1800s and the population may have slowly grown ever since. The human population in the study area may have been about 7 people/km² (or 108 000) in 1982 and may be growing at a rate of 2.5% per year. Hypotheses to explain this apparent surge in growth include (1) improved provision of food and medical inputs from outside agencies; (2) declining adherence of the population to traditional *Gada* norms; (3) external interference with the *Gada* system from national political interests; and/or (4) cyclic, functional aberrations in effects of *Gada* rules due to demographic shifts in the population.

The *Gumi Gayu*, or Assembly of the Multitudes, is chaired by the leadership and occurs once every eight years in the southern rangelands. It is a foundation of Borana life which attracts pilgrims from Ethiopia and Kenya. The assemblies of 1966 and 1988 are discussed in terms of key cultural and political proclamations. For 1988 the proclamations were indicative of a society under resource pressure. These included decrees to better maintain water points, restrict cultivation, establish calf fodder reserves, protect valuable indigenous trees, reclaim grazing reserves for cattle and prohibit water sales and alcohol abuse.

Chapter 3: Vegetation dynamics and resource use

This chapter reviews ecological site-classification and mapping of the central Borana Plateau and aspects of environmental change induced by pastoral land use. A secondary objective is to highlight the use of native vegetation by pastoral households and livestock. An ecological map (at a scale of 1:500 000) is presented that integrates soils, vegetation and climate in defining six agro-ecological zones for a 26 600-km² area. The zones include subhumid (6.5% of the region), upper semi-arid (22.4%), lower semi-arid (40.3%), arid (19.2%) and bottomlands (11.6%). Zones vary in resource dynamics and management. For example, while the subhumid zone has recently been stable in terms of the area of forests, the upper semi-arid zone has been vulnerable to grazing-induced bush encroachment. Roughly 16 species of woody plants have been implicated as encroachers in the southern rangelands. Traditional pastoral units of resource allocation (or *madda*) vary in extent of zonal diversity. Three of 29 *madda* contain six zones while 10 others contain three zones or less. By the mid-1980s about 40% of the study area had experienced significant bush encroachment while erosion, attributable to grazing pressure, affected 19% of the study area. These trends are coincident and most apparent in the upper semi-arid regions that have hilly relief and in the vicinity of permanent water development where pastoralists have become more sedentary. Less than 2% of the study area was under small-scale cultivation in 1986 following the 1983–84 drought and this was concentrated in bottomlands and upland sites in subhumid and upper semi-arid zones.

It is postulated that variation in the long-term grazing history of *madda* can be assessed using inventories of woody plant populations. It is hypothesised that heavy grazing of herbaceous plants by cattle increases woody cover by reducing fire risk. For example, sites currently enduring heavy grazing pressure could be identified by high densities of very young woody plants, while sites that had heavy grazing pressure in the past that was discontinued several decades ago could be identified from moderate to high densities of mature woody plants. It is contended that the Boran used to exploit the rangeland in terms of a sustainable patch dynamic, but that this has recently been compromised by high population growth. The patch dynamic may have consisted of the following stages: (1) pastoralists settled around a group of wells characterised by mixed savannah vegetation; (2) cattle depleted the local environment by over-utilising the grass layer and transporting nutrients to corrals at encampments; (3) woody plants invaded as competition from grasses was lessened and fire risks reduced; (4) negative change in vegetation for cattle encouraged pastoralists to abandon the area; (5) maturing stands of woody plants restricted access by herbivores and added nutrients to soils through leaf litter; and (6) the grass layer gradually recovered to an extent where fire risk increased and fires re-established mixed savannah vegetation by thinning stands of woody plants. It is at this stage that the site could be re-occupied by pastoralists; it has been speculated that this cycle could take 60 to 100 years to complete.

Comparative analyses of upland sites subjected to continuous grazing versus those protected for seven years suggest that perennial grasses are relatively resilient in terms of cover and productivity in response to grazing. The major effect of continuous grazing over the short-term appears to be encouragement of forbs that probably have a lower grazing value for cattle. Other studies indicate that it is difficult to generalise concerning interactions among woody and herbaceous vegetation due to effects of species, woody plant density and site. Tree removal experiments suggest that some woody species can reduce herbaceous production over 50%. Other research indicates that herbaceous cover can increase under canopies of other species of large trees. Local informants report that a moderate degree of woody encroachment can be beneficial to the diversity of the grazing system overall, but once encroachment becomes advanced it usually has negative consequences for pastoralism. During the 1980s the Boran noted that they were less able to burn the rangelands than in earlier times because of Government policy prohibiting burning; and the need to use standing herbage as forage, not fuel, because of high numbers of cattle. The Boran commonly offer the view that range trend is declining as a result of high stocking rates. Higher densities of people also reportedly preclude the freer movements of households that characterised previous generations.

Studies of the population ecology of two encroaching woody species (*Acacia brevispica* and *A. drepanolobium*) indicate that: (1) large quantities of seeds are produced during the warm, dry season (i.e. November through March); (2) seed pools are largely at the soil surface; (3) despite substantial seed production, recruitment of seedlings is very low probably due, in large measure, to parasitism and predation on seeds by insects; and (4) seeds vary in terms of ecological cues required for germination. *Acacia brevispica* seeds may be stimulated to germinate by fire. Seeds of both species germinate more in response to additional moisture and shallow planting depths (<3 cm); neither species appears to rely on maintaining a large seed pool in the soil. Seedling establishment is probably thus an episodic phenomenon dependent on coincident factors related to grazing pressure, insect populations and rainfall in the current year of seed production.

Analysis of livestock food habits in the upper semi-arid zone indicates that cattle and camels are exclusively grazers and browsers, respectively. Sheep (with 36% dietary browse) and goats (84% dietary browse) are mixed feeders. Only two of 29 browse species provided most of the browse forage overall and one (*A. brevispica*) is commonly regarded by range managers as an encroacher. Other important species that should receive development attention as forage resources include browses such as *Euclea shiperi*, *Dichrostachys cinera*, *Rhus natalensis*, *Pappea capensis*, *Acacia etbaica*, *Grewia tembensis*, *G. bicolor*, *Ormocarpum mimosoides*, *Acacia tortilis*, *Balanites* spp, *Cadaba farinosa* and *Capparis tomentosa*.

Browse species vary markedly in morphology and concentrations of tannins and other anti-nutritional factors for livestock. Goats, camels and sheep appeared to select against browses with higher levels of phenolic compounds especially during wet seasons when forage abundance and diversity were greatest. A variety of native grasses are also critical for the production system. Grasses important for calf feeding include *Pennisetum*, *Chrysopogon*, *Cynodon* and *Cenchrus* spp. Native plants have many uses as human food, medicine, construction materials and other cultural roles. A list of 114 plant species and their uses in the Borana household economy is provided. Few common species have no utility. Woody species that are increasing in the environment and apparently have low value for forage and household use include *Acacia drepanolobium*, *Albizia amare*, *Acacia horrida* and *A. mellifera*.

Chapter 4: Borana household economy

This chapter reviews aspects of Borana household composition and economy as they pertain to average rainfall years in the 1980s. Related topics include labour allocation, livestock marketing, milk processing, dairy marketing and cultivation. Production units are defined as typically consisting of a male household head, one wife, two to three children and perhaps several other live-in relatives dependent upon the livestock for which the household head

assumes management responsibility. Men are largely the strategists for livestock production, while women carry out day-to-day management and retain primary responsibility for dairy-related activities. Widowed women may comprise 20 to 25% of household heads, especially within 30 km of urban areas. These women may have greater managerial and strategic roles in the society than married women in general. Labour allocation is profiled on a daily basis for married women in different seasons, and for males and females at the encampment and regional level of resolution. Herding and watering animals dominate labour requirements overall and labour budgets suggest that labour is likely to be a common constraint in dry seasons.

The average production unit may include some 15 cattle (with eight milking cows), seven small ruminants, an occasional equine or camel for transport and a few chickens. Marked wealth stratification is evident. Some families have only one or two milk cows while others may have over 40. Fifty-one per cent of a sampled population (N=633) were considered poor in terms of per capita livestock holdings, 31% were intermediate while 18% were wealthy. Annual cash income may range from US\$ 45 (poor) through US\$ 217 (intermediate) to US\$ 382 (wealthy), but cash income is not entirely indicative of wealth. Annual gross revenue, including commercial plus subsistence production, may average US\$ 975 and at least 90% of this is derived from cattle; 40% accrues from milk production. Gross revenue is divided between that derived from marketing (31%) and that for subsistence (69%).

Probably less than 1% of animal outputs are used as crop inputs, thus the average household retains a pastoral, rather than agropastoral, orientation with little crop-livestock integration. Small agropastoral communities appear to be growing in the wetter parts of the study area and the immigrants include poorer people who have dropped out of the pastoral sector. Cultivated plots (<0.5 ha/plot on average) occur throughout the plateau (at an average of 3.2 plots/km²) and these are largely planted to maize in the long rains and cowpea (*Vigna* spp) in the short rains. Increased cultivation is attributable to a declining ratio of livestock:people as exacerbated by human population growth and drought. Men and women share duties in cultivation and animals are occasionally used for ploughing. About 1.4% of the study area was cultivated in 1986, representing 5% of the arable land. Assuming recent, high rates of crop expansion in the post-drought period of 1984-86 (i.e. 90 km²/year), all arable land could be utilised in the next two generations. This estimate may be conservative if animal traction becomes more pervasive and other assumptions hold untrue. Compared with similar African systems, densities of people and livestock:human ratios suggest that preconditions now exist to force a widespread shift to agropastoralism on the plateau where the environment permits and in the absence of other development opportunities. The population, however, has probably been partially dependent on grain purchases for at least the past 25 years. A shift to agropastoralism could allow some Boran to procure more food energy and still restrict sales of animals for grain purchases so that herd capital can be retained for other purposes.

Analysis of 67 803 records of livestock sales from the early 1980s confirmed that (1) cattle were by far the dominant species marketed; (2) cattle sales were dominated by mature males (52% of volume); and (3) supply of animals was highly variable among markets and years. Studies of livestock marketing rationale suggest that the Boran prefer to avoid cattle sales in light of the need for animal accumulation; are increasingly forced to sell cattle to procure food grain; may diversify more into small ruminants as a replacement commodity to reduce prospects of having to sell cattle; tend to sell in dry seasons when they have an acute need for money; and prefer to sell mature male cattle because income is sufficient to procure goods and replacement calves, thus satisfying several objectives. The poor are often forced to sell immature cattle because of the low number and diversity of animals held. This implies that the poor sell immatures to cover cash needs with no prospects for animal replacement. Increased numbers of immature cattle in markets may thus be an indicator of increasing poverty and not a sign that the production system is being transformed in a "progressive" fashion according to Western models of production. Likewise, immatures are not "fattened" for market because the herd owner does not plan to sell an immature in advance; this instead is an acute response to a need for money.

Borana herd owners report that should cattle prices increase and prices of consumer goods remain constant the ultimate response over time would be a lower throughput of cattle through marketing channels. The Boran seek higher prices, however, precisely to reduce the number of cattle households have to sell in the long-term. This is the main incentive for selling cattle on the black market with Kenya. If the same scenario were to occur for small ruminants, the ultimate response would be a higher throughput because these species are perceived to have lower socio-economic utility and greater production risks than cattle. Despite the persistence of such traditional values, younger herd owners in peri-urban locations are becoming more interested in trade. There is also a general and increasing awareness of the necessity for markets to promote survival of the society at large. Herd owners report that should Ethiopian prices for livestock become similar to those offered by Kenya, they prefer to sell their animals to Ethiopian interests.

Traditional methods for processing cow milk are reviewed; common products are fresh milk, butter, buttermilk, soured milks and ghee. Butter and fresh milk are commonly sold by households residing within 30 km of a market. Butter tends to be sold more by wealthier households further from markets, while fresh milk is sold relatively more by poorer households living closer to markets. Proceeds from dairy sales are controlled by women and are important to all families, averaging around 20% of the annual income. Dairy sales decline markedly in dry seasons compared with wet seasons and families residing within 10 km of a market reportedly sold 16 times more products than those residing 21–30 km from a market. Dairy sales are often the main source of regular income for the poorest households, which have little else to sell. This justifies settlement of poorer households in peri-urban areas and underscores the importance of local market opportunities generated by small towns. Increased dairy sales by poorer households close to markets that have lower-producing milk cows may pose health risks for calves because of nutritional stress accruing from increased milk restriction. This could jeopardise calf recruitment, and thus prospects for herd growth, for the peri-urban poor.

Chapter 5: Livestock husbandry and production

This chapter highlights work from experimental trials and producer surveys concerning livestock management and productivity in the Borana system. Most of these studies were conducted in average rainfall years under conditions of moderate to high stocking rates of cattle. The primary focus is on cattle, which are the most important livestock species to the Boran. Ancillary livestock include small ruminants, camels, equines and poultry.

General aspects of cattle husbandry including maintenance of a female-dominated herd structure, allocation of animals to local or satellite herds to conserve local resources, uncontrolled breeding, milking management for cows, intensive hand-rearing of nursing calves and differentiation of labour according to gender and age are similar to elsewhere in semi-arid Africa. One unusual feature, however, is a high degree of water restriction for cattle during dry seasons such that animals may be watered only once every three to four days. This practice is probably permitted, in part, by the relatively cool ambient temperatures which help cattle conserve body water otherwise used for thermoregulation. Restricted watering is a long-held practice of the Boran that has positive attributes in terms of conserving human labour, extending grazing radii from water points and increasing water-use efficiency. Results from trials conducted under ranch conditions indicate that cattle watered once every three days during dry seasons may lose weight faster than those on daily watering. This is because restricted watering reduces forage intake; however, cattle on restricted watering can compensate by regaining weight faster during subsequent rainy periods. One significant short-term cost of restricted watering, however, is a reduction in milk production of around 13%. The ability of cattle on restricted watering to regain weight or minimise reduction in milk production is probably constrained to a higher degree under the high stocking rates characteristic of pastoral management compared with those observed under experimental conditions.

A general synthesis of key aspects of productivity and management for mature cattle indicates that (1) the ratio of females to males in the regional cattle herd is 71:29; (2) cows

have their first calf at 4 to 4.5 years of age and may produce an average of 6 to 6.5 calves over a reproductive life of 8 to 8.5 years; (3) the average calving interval is 14 to 15 months; (4) milk yields/cow range from 680 to 1000 kg for lactations which vary from seven to 13 months, respectively; (5) the median milk yield/cow is 850 kg over 320 days (or 2.6 kg/head/day); (6) annual calving rates average around 70%; (7) mature weights for Boran bulls and cows are 400 and 225 kg, respectively; and (8) mortality rates for animals >2 years of age are <5% per annum in average to dry rainfall years. These productivity figures appear reasonably good for cattle under traditional pastoral management and are even comparable to the lower range of productivity values for animals reared under ranching and research station conditions in sub-Saharan Africa. This provides some circumstantial evidence to support contentions that indigenous Boran cattle are relatively more productive than other African breeds and/or that the central Borana Plateau is a particularly good environment for cattle production.

Season has a dramatic effect on cattle breeding and milk production. Nearly 70% of calf births occur during the long rains and another 17% during the short rains. Daily milk production/cow roughly doubles in rainy seasons compared with dry seasons and during dry seasons fewer cows are lactating. Lactation curves are unusual in that they may have a bimodal, rather than unimodal, shape which probably illustrates acute seasonal constraints in cow nutrition during some years. Cattle productivity may also vary with regards to wealth class of pastoral households. Cows held by poor households reportedly have lower calving rates, lower milk production, lower absolute milk offtake for human consumption, lower milk intake for calves and higher rates of calf mortality than cows held by wealthier households. These patterns may be largely attributable to a higher milking intensity in poorer households.

Productivity may also be influenced by grade of cow. The Boran recognise three classes of milk cows (i.e. high, intermediate and low producers) and these vary substantially in terms of daily yields, with high producers yielding over 50% more milk than low producers. Household surveys suggest that despite greater milk production in higher-producing cows, they may have a longer calving interval than lower producers. Costs of higher milk production may thus be related to the extent to which higher-producing cows must mine body reserves in support of lactation, which may then compromise reproduction. Different production classes of cows may also vary in terms of vulnerability to resource restriction during dry years and drought. Informants report that high milk producers are among the first to perish during difficult circumstances. Another important factor that limits milk production efficiency is ticks. A survey of 560 milk cows indicated that 13% of teats were closed as a result of tick-induced damage. This implies that an average eight-cow household may need one extra cow simply to offset this loss in milk production capacity.

Compared with other aspects of cattle productivity, calf growth rates appear to be low. Birth weights average 18 kg and are affected by season of parturition. Field studies that quantified growth from birth to 210 days of age indicate average daily gains for nursing calves are variable but approximately 136 g/head/day, typically <1% of live weight. Growth is probably substantially influenced by competition with humans for milk, as milk offtake for people averages 30 to 40% of total yields in general. At 250 days of age a calf which consumes 195 kg of a milk yield (i.e. 35% of production) may weigh around 60 kg, which is only 45% of the live weight of 132 kg projected had the calf had access to all the milk.

Calf mortality rate appears high and similar to that in other pastoral systems in Africa. Producer surveys suggest mortality rates and sources vary according to interactions among wealth of pastoral households and type of rainfall year. Averaged over all years, wealthy, intermediate and poor households reported calf mortality rates of 24%, 16% and 30%, respectively. It has been postulated that the high mortality rates for calves of the wealthy are primarily caused by disease-related factors that result from a reduced management input per calf. The higher mortality rates for calves held by the poor are probably more related to nutritional stress arising from competition with people for milk. Across all households in a modal rainfall year calf mortality may average 22 to 25%. Roughly half of the deaths are primarily due to poor nutrition and the other half are caused by health complications such as calf scours, black leg, pasteurolosis and foot-and-mouth disease. In a dry year mortality rates

are similar, but two-thirds of the losses are directly attributable to nutrition. In a drought year 70 to 90% of the calf crop may be lost, all primarily due to poor nutrition.

Calf management is typically performed by married women and the pattern of management changes depending on season of birth of the calf. Calves born during the dry seasons or short rains typically receive more intensive care, which reflects greater scarcity of resources and higher competition with people for milk during these times. Management by women includes gathering cut-and-carry forage and hauling water for relatively immobile calves which are kept in or near the family hut.

More limited observations on ancillary livestock suggest that productivity and management practices for goats, sheep and camels are similar to what is found elsewhere in semi-arid Africa. Exceptions may include that sheep are apparently rarely milked in average rainfall years and breeding among small ruminants is uncontrolled. Camels serve various purposes depending on ethnic group; the minority Gabra rely on camels mostly as a milk producer, while the Boran use camels more for hauling goods and occasionally for pulling ploughs. In contrast to cattle, disease appears to be a more pervasive constraint to production of small ruminants and camels. This may be an artefact of the relatively moist conditions in which these species are commonly held in upper semi-arid and subhumid locations. Equines are often observed on the Borana Plateau but occur at low population densities. Donkeys are used to haul goods, while mules and horses are ridden by men. Little is known about the importance of chickens to the Borana household, even though they can be frequently seen in encampments. It is postulated that chickens may be an increasingly important market item for Borana households in peri-urban locations.

Chapter 6: Effects of drought and traditional tactics for drought mitigation

This chapter primarily reviews impacts of the 1983–84 drought on the Borana production system and outlines key tactics that households used in response to drought. A secondary objective is to highlight effects of another drought in 1990–91 and interpret cattle population dynamics observed from 1982–91 within an ecological framework of density-independent or density-dependent regulation of population size. Most of the empirical findings in this chapter are consistent with the literature on drought responses of pastoral populations in East Africa.

The 1983–84 drought was driven by rainfall deficits during four consecutive wet seasons over two years. Most research was conducted by monitoring five encampments in the central zone (i.e. lower semi-arid) where drought impacts were most severe. In terms of livestock management, an early response to the first failure of the long rains in April 1983 was to shift allocation of cattle from a ratio of 71:29 for home-based and satellite herds, respectively, to a ratio of 34:66 within seven months. Many of the satellite herds (consisting of hardy immatures, dry cows and males) moved from central zones to drought-reserve areas at the periphery of the central plateau during the first year. These reserves were characterised by either an improved forage base plus reliable deep wells (as in the Web region), or by flushes of forage production stimulated by more frequent rainfall at higher elevations (as to the north of Did Hara).

Once these reserves were depleted, satellite herds began to endure higher rates of losses and moved off the central plateau during the second year to secure grazing towards the southern Ethiopian highlands and in northern Kenya. The net result was a reduction of 50% in cattle density in the study area by 1985. Patterns for other livestock species were less well documented. Sheep and goat flocks may have travelled extensively in some situations, but overall they appeared to maintain their population densities in most locales compared with cattle during the drought. The small camel population appeared to increase during the drought by 45% and this was probably due to immigration of camels from adjacent regions.

The main effects of drought on the production system were mediated through cow nutrition due to reduced forage production. Compared with a dry season of an average rainfall year, the acute effects of the 1983–84 drought reduced daily milk offtake to an average

household by 92% (i.e. from 5 l/family/day to 416 ml/family/day). Eighty per cent of this decline was caused by a drop in calving rate from 75 to 9%, with the remainder contributed by a drop in daily offtake per lactating cow from 500 to 260 ml. A minor part of this milk deficit was made up by small ruminants at Borana encampments, however, as 60% of 200 female goats and 50% of 113 ewes were lactating during the height of the drought.

Human diets were normally dominated by cow milk (55%) and cereals (32%) on a gross energy basis sufficient for maintenance and growth in average rainfall years. This shifted to a situation during drought in which cereals dominated (52%) compared with milk (14%) and meat and blood combined (2%), with an average per capita caloric deficit of 27%. The reported duration of acute hunger was 32 months from August 1983 to April 1986. People compensated for reduced food production by (1) prioritising young children to receive milk; (2) shifting diet composition for other age groups to include more cereals, meat and blood to accommodate needs of children; (3) reducing size and frequency of meals for adults and older youths; and (4) sending the elderly or other volunteers to famine relief camps as a last resort. Roughly 27% of surveyed households in 60 encampments changed location during the drought, but there was no evidence of mass migrations. The general impression was that most people attempted to stay in one place and wait out the drought.

Maize, sorghum, enset (*Ensete ventricosum*) and sugar were sources of food energy in the surveyed regions. Gathered bush foods (bulbs, fruits, gum and roots) assumed greater importance in drought but still represented opportunistic sources of nutrients rather than staples. Hunting was not important. Cattle hides were reportedly boiled and eaten in some instances. Famine relief did not occur until late 1985 and thus was largely unimportant during the two years of low rainfall (i.e. 1983–84). Human diets began to improve rapidly with the onset of average rainfall in April 1985. Although morbidity in the human population was widespread during the drought, surveys indicate that incidence of drought-induced mortality was low (i.e. %). About 18% of the population may have moved to famine relief camps by 1985. In a survey of 48 families in the upper semi-arid zone most families reported one birth during the drought suggesting that the human population grew, although at a rate slower than normal.

Besides dramatic declines in milk production, the other major effect of the drought was to reduce pastoral terms of trade by 90%. Pre-drought prices of Ethiopian Birr 1.00 per kilogram of live weight for cattle declined to Ethiopian Birr 0.30 by 1984. This was mirrored by an increase in maize prices from Ethiopian Birr 0.40 per kilogram to Ethiopian Birr 1.00 over the same time frame. Other important consumer goods increased in price while livestock species decreased in price. Cereals were thus commonly available in markets, but the high cost relative to livestock reduced effective demand. Low livestock prices resulted from high supply and low demand, particularly in the second drought year. The strategy of families during the first year may have been to sell a similar number of animals as in average rainfall years, but to use more of the income to purchase food grains (i.e. 66% versus 30% of income used to buy food). In contrast to the first year, animal offtake rates probably markedly increased in the second drought year in response to a much greater need for food. Although cattle were often documented to be sold to buy grain near the end of the drought, livestock were not always mentioned as the most important sources of income. A peri-urban sample of 48 pastoral households in the upper semi-arid zone revealed that milk, household utensils, firewood and other bush commodities were reportedly more important than livestock as frequent sources of income. Credit was not available from merchants for food purchases. Temporary employment as labourers was secured by members of 27% of 43 peri-urban households in the upper semi-arid zone.

Losses of assets due to drought were high. Monitored cattle herds experienced a net loss of 60% (N = 4143), with 42% lost to mortalities, 14% to sale and 4% to slaughter. Losses differentially occurred depending on age and sex class. A hypothesis is forwarded that cattle mortality occurs in distinct waves over time, with the most productive cows perishing earlier on. Cattle losses ranged from 40 to 90% of immatures, 45% of mature cows and 22% of mature males. Immatures were vulnerable because of lack of milk and low mobility while milking cows were vulnerable because of their higher nutritional requirements and tendency to be kept nearer to over-utilised encampment areas. Mature males were less vulnerable

because of their general hardiness and high mobility. Mature males were more commonly sold to purchase grain. Small ruminants (N=788) experienced a 16% mortality rate, with 15% sold and 7% slaughtered. Net reduction in this population throughout the drought was minimal, however, because births tended to balance losses.

A survey of 96 Borana and Gabra households in the upper semi-arid zone indicated that effects of ethnic group and household wealth were important factors in mitigating asset losses. Poor households tended to have lower producing cows than wealthier households. Poor Borana and Gabra households lost 52% of their cattle compared with 28% for the wealthy due to higher rates of mortality, sales and slaughter. Poor Gabra lost over 60% of their camels compared with an average of 40% for other Gabra wealth classes.

There was thus no evidence that camels were any less susceptible to drought than cattle in terms of mortality in this instance. Key advantages in having camels, however, may lie more in terms of persistence of milk production for home consumption and sale and use of male camels for transporting grain. Interviews in the upper semi-arid zone suggested that at the height of the drought cows yielded an average milk offtake of 140 ml/head/day over a lactation period of six months, while camels yielded 770 ml/head/day over nine months. The overall pattern of livestock use during drought suggests that animals were not held for quick disposal or sale during times of stress. Instead, they appear to be assets which are held as long as possible in anticipation that conditions will soon improve. Families are apparently willing to undergo great hardship before they are forced to sell animals. This behaviour has large implications for exacerbating drought impacts on the population.

Due to favourable rainfall from 1985 onwards, the mature cow component of the regional herd had probably recovered in terms of numbers and productivity by 1989 (or even earlier). Thus the impact of the 1983–84 drought was felt for six years overall. Opportunistic cultivation of cereals by pastoralists during 1985–89 was an important means of ameliorating hunger, as were emergency feeding programmes during 1985–87. Deficient rainfall in 1990–91 again resulted in large losses of livestock, hardship for pastoralists and re-initiation of famine-relief activities.

It is concluded that the cattle production system is remarkably resilient, but that density-dependent factors are increasingly having negative effects on livestock populations and human welfare. In terms of cattle performance, the Borana system thus appears to be an equilibrational production system in which increased stocking rates raise the risk of negative impacts on animal mortality rates and productivity.

A hypothesis is forwarded that an apparent increased frequency and severity of drought on the Borana Plateau is ultimately an artefact of a high and unsustainable density of people and not a changing rainfall pattern. Traditional drought reserves are probably being increasingly compromised during normal rainfall years as a result of overflow human settlement and unregulated grazing. Opportunities for widespread dispersal of stock during drought are also becoming more limited as a result of general population increases in southern Ethiopia and northern Kenya. The human condition on the Borana Plateau has been recently disrupted further by weapons proliferation, ethnic clashes and marketing interruptions culminating from the demise of the previous government in 1990. The ethnic clashes, in part, are probably attributable to competition for increasingly scarce grazing and water resources.

Chapter 7: Development intervention concepts

This chapter reviews (1) contemporary issues in African pastoral development; (2) a development philosophy appropriate for the Borana situation; (3) perceived impacts of interventions implemented in the southern rangelands since the 1960s; (4) a mechanistic and comprehensive theory within which future social, economic, ecological and agricultural dynamics of the system can be predicted; and (5) a practical framework for development impact which employs a systems approach combined with commodity-based research and insights derived from local development experience.

Despite spending millions of dollars on infrastructural improvements and livestock services in the southern rangelands since the 1960s, range development planners concede

that the impact of interventions has been far below their expectations. Planners had assumed that once animal health status was improved and market outlets were available by the late 1970s, dramatic increases in cattle offtake for domestic consumption and export would occur. This was also supposed to lead to higher incomes and an improved standard of living for the Boran. Instead, the net result appears to be a larger population of cattle capable of degrading the land and a human population increasingly dependent on relief and rehabilitation. This negative outcome is consistent with the mainstream view of pastoral development problems observed throughout Africa. While the situation for the Boran is indeed deteriorating today, it is argued that past interventions had value by helping delay an inevitable decline in the production system that ultimately results from rapid growth of a human population which is dependent on a finite resource base. It is postulated that impact of future interventions can be maximised if implementation is properly timed with respect to population pressure. Population pressure thus can create new opportunities for positive change.

Rather than discount the value of past interventions, Borana leaders have noted numerous, positive impacts on their lives from veterinary campaigns and development of roads, ponds and markets. Population studies suggest that while marketed offtake of cattle has been slow to respond to improved infrastructure, it should greatly increase by the turn of the century as a result of population pressure and food deficits which will force the Boran to trade more animal products for cereals. Increased dependency on external resources, however, will be very dangerous for the Boran if markets are not operating efficiently and at favourable terms of trade. Under-utilised in the past, roads and markets will become the future lifeline for Borana society. The ponds and veterinary services reportedly delayed the onset of poverty for many households in the 1970s and 1980s by improving access to new land and providing more cattle.

It thus appears that increased cattle production from extensive interventions tended to be absorbed by a growing population for subsistence rather than marketed. Opportunities for further extensive interventions are now limited, however, and windows are opening for the application of new policies and technical innovations which were non-existent a decade ago. Increased bottom-up demand for interventions will result from heightened human competition for resources. Using an inter-disciplinary systems approach suggests that changes in Borana society, economy and environment are somewhat predictable and can thus shape a framework for development intervention.

Based on seven years of observation, it is hypothesised that the production system is subjected to two simultaneous processes, namely a long-term trend which results from a declining ratio of cattle:people and short-term cycles which occur as a result of variable stocking rates of cattle. The long-term trend occurs because growth in the human population is rapid and steady, but growth in the cattle population is primarily limited by scarcity of land. The short-term trend occurs because a two-year drought can reduce total cattle inventory by over 50%. Stocking rates can thus vary from <10 head/km² during early years of drought recovery to >20 head/km² a few years later if intervening rainfall is adequate. These periods are referred to as the drought-recovery phase and high-density phase, respectively. This dramatic shift in stocking rate is postulated to cause large variation in livestock output per head and per unit area. Milk output per cow gradually declines as a function of an increasing stocking rate; this infers that cow productivity is strongly influenced by forage competition. However, milk output per unit area, which reflects stocking rate of cows as well as productivity per cow, is the most important variable. Milk output per unit area probably gradually rises during drought recovery, briefly peaks and then declines as a result of forage competition among cattle. This optimisation pattern is postulated to drive a cycle of short-term social and economic adjustments by the Boran.

In the absence of development interventions, there should be a number of predictable outcomes for the Boran over the long-term. These have been deduced from observations in the southern rangelands and from the pastoral literature. These include (1) an increasing annual deficit in food energy, produced by traditional means, for the people that will approach 60% by the turn of the century; (2) a permanent and expanding effort to cultivate; (3) increased offtake of cattle to buy grain; (4) annexation of higher-potential land for forage reserves serving calves and immobile cows; (5) increased emigration of young males leading

to key labour shortages; (6) increased wealth stratification; (7) a growing population of peri-urban poor dependent on dairy sales for survival; (8) increased interest in small ruminant and camel production; (9) an increased milking intensity of cows and enhanced percentage of cows in the regional herd; (10) a decreasing percentage of mature male cattle as a result of increasing sales and increases in cows which will reduce risk-mitigation capability of households; (11) a decline in the use of bush foods; (12) a decline in traditional milk processing because of a lower milk surplus; (13) increased risk of environmental degradation in the form of bush encroachment; and (14) threats to the inter-generational transfer of social mores, leading to uncertainties in the maintenance of traditional rights and responsibilities.

Dynamics focusing on food procurement are attributable to a declining per capita supply of cow milk. Increased efforts by the Boran to sell dairy products and produce cereals or small ruminants are all hypothesised to result from attempts to engage in alternative activities which allow them to avoid or delay selling cattle, which are the major form of wealth generation and storage and social security in the society.

It would be difficult to observe long-term trends from year-to-year because the short-term cycles are superimposed over the long-term trends and confuse interpretation. The inter-drought cycle is speculated to result from adjustments by the Boran to secure resources when facing annually variable constraints on their food supply. The drought-recovery phase is postulated to have been observed during 1985–87. This time was characterised by (1) increasing rates of milk output per unit area due to a growing stocking rate of cows; (2) aggressive and opportunistic production values of households seeking to rapidly rebuild their cattle herds; (3) intensive efforts to cultivate cereals due to a milk deficit per unit area; (4) extensive recovery of the grass layer from previous heavy grazing, with the extent of recovery dependent on rainfall; (5) increased sales of milk from peri-urban households needing grain to cover large deficits in food energy; (6) increased sales of small ruminants to buy grain; and (7) traditional, reciprocal grazing rights among territorial groups honoured, allowing unrestricted access.

Near-recovery of per capita milk production following the 1983–84 drought is speculated to have occurred around 1988 when numbers of lactating cows peaked, but before density-dependent interactions took hold. Full recovery to pre-drought levels would not have occurred, however, because steady growth in the human population during the interim lowered the ceiling on per capita yields. This recovery year was a time of the lowest annual food-energy deficit for the Boran in the inter-drought cycle. They would have still needed to buy or cultivate cereals, but to a slightly lower extent than 1985–87 or 1989–91.

The high-density phase is postulated to have occurred from 1989 until a severe drought year in 1991. This was probably characterised by (1) declining rates of cattle production per head and per hectare due to increasing forage competition; (2) more conservative production values of wealthier households in response to increased production risks and social pressure from their peers to destock; (3) re-initiated efforts to cultivate cereals more intensively; (4) heavy grazing pressure and increased likelihood of widespread establishment of bush seedlings, the latter also dependent on rainfall; (5) increased sales of milk and butter from peri-urban households needing grain to cover food-energy deficits; (6) increased sales of small ruminants and cattle to purchase grain; and (7) reciprocal grazing rights periodically refused among territorial groups.

The development philosophy to be pursued in this system is one that first and foremost must achieve security for the Boran in terms of food procurement and asset accumulation and diversification to mitigate risks. Secondary goals are to better promote life-style choices through access to education and local urban development. Other goals include use of livestock assets to achieve improvements in access to water and other basic essentials of day-to-day life. While the challenges are daunting, changes are feasible here because of two factors: (1) the Boran have the capability to rapidly generate capital assets in the form of livestock; and (2) the Boran have repeatedly demonstrated open-mindedness in response to appropriate innovations. The development problem can be initially confronted by combining strategies to improve cattle production in conjunction with a fundamental shift in how animal assets are marketed and utilised. Because of these development priorities, system sustainability is first defined in terms of per capita production of milk and per capita

accumulation of male cattle as assets. Protecting the environment and measuring environmental sustainability is very complex and is a goal that can only be addressed after acute human needs have been met. At present per capita food production and asset accumulation are in a decline spurred by human population growth. Sustainability of these attributes could largely be enhanced by alternative investments for a portion of the cattle portfolio and increased rates of emigration of pastoralists out of the system.

Specific means to initiate development action must address an increasing need to (1) provide more human food in all types of rainfall years; (2) stabilise the system in response to drought through risk management of herd assets; (3) focus on improving aspects of livestock production that are already intensive and have a lower risk; (4) make more efficient use of existing resources; (5) facilitate use of livestock assets for economic growth and community development; and (6) nurture and complement traditional aspects of social organisation to promote indigenous management of resources and protect valued aspects of the culture.

A review of component research and recent development experience suggests that the following intervention concepts are most appropriate (1) promotion of monetisation, risk management of herd assets and improved human welfare through projects to maintain wells and ponds using heavy machinery as funded by livestock sales of the wealthy and middle class; (2) promotion of human welfare, improved labour efficiency and risk management of herd assets by extending cement cisterns funded by livestock sales to increase water supplies to households and calves; (3) promotion of grazing management schemes tailored to meet needs of specific communities; (4) rehabilitation of bush-encroached areas using prescribed fire, arboricides and charcoal production to recover labour costs; (5) hay making with local grasses to improve nutrition of hand-reared calves and reduce rates of calf mortality; (6) use of small quantities of local legume forage including acacia fruits and leaves to provide protein supplements for calf diets based on grass hay; (7) improved management of cultivated fields in appropriate sites including diversification of cereals with cowpea (*Vigna* spp) which provides seeds for human consumption and residue for supplementing calf diets based on grass hay; (8) provision of acaricides in a form to protect cow udders from tick damage to promote milk production; (9) promotion of herd diversification to include more small ruminants and camels achieved, respectively, by improvement in delivery of veterinary services and access to camel markets; and (10) promotion of local below-ground grain stores and/or regional grain stores funded through livestock sales.

Impact of technical interventions would be enhanced within a framework of policies and procedures which facilitate (1) access of pastoral development projects to modest amounts of foreign exchange to support acquisition of fuel, spare parts, chemicals and veterinary inputs; (2) timely collection and proper administration of funds collected from organised livestock sales in support of community development projects; (3) local and inter-regional trade in grain, livestock, dairy products, cement, hand tools and other basic essentials; (4) allocation of appropriate sites to be used for sustainable cultivation and charcoal production by pastoralists; (5) risk management of cattle assets including alternative investments for wealthy and middle-class households in the form of simple savings accounts in banks; (6) opportunistic provision of employment on public works projects during the second consecutive year of droughts; (7) existence of a reasonably staffed and equipped range development agency within the Ministry of Agriculture with a mandate to work in partnership with the pastoralists to prioritise finding solutions to felt needs of the community; and (9) education of pastoralists and stimulation of local urban development which could improve the likelihood that pastoralists could successfully emigrate out of the traditional system. A review of these technical and policy interventions strongly suggests that most of the ultimate constraints to effective implementation lie outside, not within, the pastoral system.

The intervention philosophy is based on meeting bottom-up demand for technology and services that the Boran are willing and able to pay for through livestock sales. This is the perfect test criterion for judging whether a certain intervention is meeting people's priorities. Many ideas that originated from top-down thinking failed in the 1980s. These failed because they lacked practical appreciation of people's priorities and constraints. For

example, interventions using animal-drawn pond scoops to maintain ponds were promoted to save foreign exchange needed to maintain heavy machinery. The scoops were found to be inappropriate because the Boran appear unwilling to risk valuable animals for extensive, communal work commitments. In contrast, use of animal traction for short-term cultivation work should be very successful.

Forage improvements based on exotics have also commonly yielded disappointing results due to constraints of rainfall and air temperature. Exotic forages also have the limitation of not directly meeting people's needs in terms of more food for themselves or helping them manage existing resources more efficiently. That is why local range management tactics, extension of dual-purpose cowpea and efforts to improve cereal crop management on appropriate sites should be very successful. Forage intervention should also be focused on low-input strategies to make better use of valuable indigenous grasses and trees. While the trees have the disadvantage of low and variable productivity, they persist well in the environment. Hay making is an excellent example of a bottom-up solution to a calf management problem using local resources. Hay making can result in marked nutritional improvements in calf performance as it is an easily transferred innovation and converts a communal grazing or cut-and-carry resource into a private resource.

Strategies to enhance cattle growth to improve life-time performance were also found to be ill-conceived in terms of lack of an appropriate social or ecological perspective and were deemed far too risky for implementation. In essence, there is no long-term cost for cattle production accruing from levels of milk offtake that averaged 170 l/head/lactation. Compensatory growth in young cattle is a powerful attribute that may often overcome the effects of early nutritional deprivation due to milk restriction. Calf mortality mitigation, in contrast to speeding up growth, is much more appropriate culturally, ecologically and economically. Drought mitigation tactics based on fodder reserves of *Atriplex* and *Opuntia* spp were also found to be ill-conceived. Although also beset by daunting constraints, alternative investment for a portion of cattle assets in the form of simple saving accounts for households is the only dramatic means to quickly achieve increased rates of cattle offtake, faster herd turnover, increased animal production, stabilisation of the cattle population in response to drought, improved risk management of assets for households, minimised risk of famine by buffering terms of trade and encouraging economic growth for households and local urban centres. This strategy could be most effective if managed in the form of a sustainable yield scenario with the regional herd held at <20 head/km². The biological and ecological postulates that underpin this strategy hold true because high stocking rates can reduce animal production and increase pastoral risks. The system thus exhibits strong equilibrium characteristics.

Using the dynamic systems model involving long-term trends and short-term cycles, in conjunction with commodity intervention concepts, reveals that windows of opportunity for different interventions may be gradually closing, gradually opening, or opening and closing in a cyclic or episodic fashion. Windows based on system extensification or utilisation of traditional surplus products are closing; these include prospects for new, large-scale water developments and milk processing technologies. Windows based on system intensification and marketing are gradually opening; these include interventions for cultivation, calf management, water management, site reclamation, grazing management, dairy and livestock marketing, risk management of livestock assets, herd diversification and promotion of human development through education.

The short-term cycles also will affect success of interventions. Those interventions dependent on low stocking rates for their success (such as site reclamation) would be most effectively carried out during a drought-recovery phase of the cattle population. Those interventions dependent on high stocking rates for their success (such as livestock-funded water development and grain stores, banking livestock assets, grazing management, hay making etc) should be promoted during high-density phases of the cattle population. Some interventions would thus be adopted, dropped and re-adopted as part of a cyclic process. This illustrates that pastoral development activities should be opportunistic and planned around anticipated, but probabilistic, dynamics of the production system. This also illustrates that systems and commodity research should be run in parallel to gain insights relevant to

achieving development impact. The commodity work helps us understand what and how to implement while systems work helps us understand when to implement commodity interventions and why.

Chapter 8: Synthesis and conclusions

The objectives of this chapter are to: offer justifications for continued investments in rangeland development in Ethiopia; forward an integrated goal for the development of the Borana pastoral system; outline tactics for a best-bet development strategy to meet this goal; note major constraints for implementing tactics; and summarise major research implications of this systems study.

The current development picture in the southern rangelands is bleak. As a result of the 1990–91 drought, roughly 200 000 pastoralists are receiving food relief and around 50% of the regional cattle herd perished. What used to be referred to as a model of sustainable pastoralism in Africa is now suffering problems regarded as endemic to pastoral Africa in general. The fundamental cause of the situation is multi-faceted. Human population growth appears rapid, but it is not appreciably different from that of similar systems. There may be, however, little opportunity or tendency for the Boran to emigrate out of their system. The lack of a means of releasing human population pressure is hypothesised as the root cause of the problem. This has been exacerbated by the cultural isolation of the Boran from the rest of Ethiopia and limited economic opportunities outside the pastoral sector. The cattle population is increasingly limited by land availability and the ratio of milk cows to people is probably in a precipitous decline. This has led to economic adjustments which include peri-urban dairy marketing and emergent agropastoralism. Negative effects are magnified because there are indications that a finite resource base is becoming smaller. Population growth, both for the Boran and neighbouring ethnic groups, is now harming their production systems because people are reportedly residing in, or otherwise using, internal and external grazing reserves to an increasing degree. These reserves used to be held as buffers to protect cattle herds against drought. Mix these problems with a dry-year probability of 0.20 and the recipe is disaster.

This negative trend has occurred despite large investments in infrastructure during the 1970s and 1980s. While it is extremely fortuitous that roads and markets are now in place to accommodate future changes in the system, there are several reasons why development planners and expert consultants failed to envision the scenario which has unfolded today. First, it was wrongly assumed that the Boran had Western values and were eager to raise cattle for cash; and second, there was a poor understanding of how population pressure drives social and economic change. Interventions mostly occurred at an earlier time when it was not necessary for the Boran to change their traditional life-style. Now, because of a high population density, they have to change in order to better feed themselves, but the problem today more resembles crisis management than development. Some of today's crises could have been averted if the same attention had been given to education and development of human potential as was given to how to stimulate cattle production and offtake. Planners will be pleased to know that the Boran should market a higher percentage of cattle in the future and on average these will be younger animals. This is not, however, due to a revolution in commercial attitudes but to the Boran being forced to sell more animals to buy grain. One consequence is that the Boran are now vulnerable to unstable markets and cattle inventories could be depleted to an extent that endangers asset accumulation and drought recovery and encourages poverty.

It is forwarded that the goals of rural development should include agricultural growth in the form of livestock production, poverty alleviation and increased ecological sustainability. If no measures are taken to promote economic development of the Borana system, the prospect is that the chances for agricultural growth will decline, poverty will increase and ecological sustainability will be compromised by increased cereal cultivation on fragile upland soils to mitigate famine risk and from additional bush encroachment and soil erosion induced by cattle grazing.

Because of the large area and high population density, the highlands should receive priority attention for agricultural development in Ethiopia. The rangelands cannot be ignored in the national interest, however, because they will increasingly serve as extensive breeding grounds for animals used in the highlands and for diversification of exports. It is speculated that the highlands of the future will become increasingly crowded to the extent that smallholders will become less able to control the entire process of producing large stock from birth to finishing. They thus will demand a greater supply of cattle that have been bred elsewhere for finishing or draft.

Pre-conditions may now exist, both in the highlands and lowlands, to achieve the goal of national agricultural integration envisioned in the early 1970s if policies and provision of technology and inputs are adequate. The highlands and lowlands offer complementary production advantages which can be better exploited. Benefits of national integration now occur in two directions; besides smallholders benefiting from an enhanced supply of range-bred stock, populations like the Boran are in dire need of highlands grain at reasonable terms of trade to offset the chronic risk of famine.

The broad view is that interventions in the southern rangelands need to promote sustainability of the traditional social order as well as ecological sustainability of livestock production. Both are inter-related; famine risk, poverty and undermining of cultural values threaten the social order. Increased competition and density-dependent patterns of livestock production suggest that more households will be gradually forced out of the traditional sector during droughts. The population of peri-urban poor would increase and this could become a negative factor in the social welfare of small towns. It is also speculated that failure to deal with these problems means the system could begin to collapse as a result of increased regional insecurity and enhanced difficulties in maintaining operation of the deep wells without coordinated human inputs. Without the deep wells in full operation, the livestock production system could be markedly less efficient and unsustainable. Technology for reliably raising well water under low-input conditions is deemed inappropriate at this time. Enhancing prospects for ecological sustainability is a longer-term issue that requires a hierarchical, and step-wise, approach to rural development. If the production system is not stabilised in response to drought, there are negative implications for the Boran in terms of loss of animals that could otherwise be marketed and increased variability in marketed offtake for the nation.

Although the challenge is daunting, the fundamental premise of this chapter is that the entire Borana system can be managed to increase agricultural growth, alleviate poverty and reduce risks to the environment using several key interventions in tandem. These measures should also help stabilise the system in response to drought. This has positive implications for reducing the outward flow of destitute people over the short-term and reducing losses of milk cows which reduces the need for unsustainable cereal cultivation during drought recovery. It also could assist efforts to preserve the Boran cattle breed which would reduce the need for the Boran to trade their cattle for inferior highland cows during drought recovery.

The time when one development agency, or a few technologies, could have significant impact on the Borana system is now over. Managing the system for widespread impact today requires a greater focus on the effects of policy and the coordinated action among several development agencies and government ministries. The strategy advocated here is also not unduly expensive to implement.

Forwarded in the previous chapter, the theory of local system dynamics implies that development action must deal with two phenomena, namely the long-term trend of a decline in the ratio of cattle to people and the inter-drought cycle consisting of the drought-recovery phase and the high-density phase. Development must also deal with problems in order of their immediate importance to Borana society: (1) improve food security; (2) reduce risks of animal production and asset accumulation; (3) enhance livestock production and herd turnover; and (4) deal with ecological sustainability and poverty over the longer term through population management. Assuming that the first goal can be achieved, attainment of the second goal is the key to everything else. Some interventions can address both the long-term trend and the inter-drought cycle simultaneously.

Using the framework above, means that dealing with the long-term trend can be started now, but the effects will not be felt for a few years. In contrast, the inter-drought cycle can

be dealt with immediately with faster results. An example is described in which the drought-recovery phase is comprised of the years 1992–96 and the high-density phase occurs after 1997. In general terms, the drought-recovery phase is when cattle-stocking rates are <20 head/km² and the high-density phase is when stocking rates are >20 head/km². This schema is overly simplistic because variability in rainfall or incidence of epidemic disease could disrupt herd growth patterns. The inter-drought cycle may be quite predictable, however, considering rainfall. For example, there is a 0.75 chance that the years 1992–96 will have one dry year or less and will thus support rapid herd growth. There is a 0.25 chance that lack of rainfall would slow herd growth. Once the high-density phase occurs, there is a 0.50 chance of low rainfall in at least one of the first three years and thus a high probability of a drought-induced population crash. This underscores the impression that the occurrence of drought impact is influenced as much by the cattle population as by rainfall and leads to the speculation that a major crash could now occur once every five to 10 years unless action is taken to stabilise the system.

Measures to deal with the long-term trend are needed to maintain favourable terms of trade of livestock for grain, stabilise the cattle population in response to drought and facilitate the ability of a portion of the Borana population to emigrate. Ultimately, the future of the Boran will be greatly influenced by the trajectory of small towns in the rangelands, both as market outlets and sources of employment. The step-wise approach is to first improve food security through local cereal production as a temporary measure and open regional marketing channels, and secondly to gradually increase the ratio of cattle to people by incremental increases in livestock-carrying capacity and stimulation of human emigration. Major activities include national, regional and local policy initiatives: (1) stimulate maize production to promote surpluses in the southern highlands, encourage inter-regional commerce and de-regulate producer prices for livestock and grain; (2) encourage local maintenance and development of infrastructure and transport networks in the southern rangelands to improve market access and promote growth of towns like Yabelo, Moyale, Mega and Negele; (3) support development agencies in the southern rangelands and encourage their interaction with the Boran on the basis of participatory development that focuses on felt needs of the community; (4) devise a land-use policy in recognition of the need for the Boran to cultivate only on ecologically sustainable sites, maintain viable grazing areas within *madda* that provide a framework for reclaiming drought reserves from human encroachment; (5) increase access of the Boran to elementary education; and (6) initiate plans to increase access of the Boran to the commercial banking sector and consider strategies to use banked livestock capital to stimulate economic growth in the small towns.

Means to deal with the drought-recovery phase during 1992–96 should complement strategies employed by the Boran. These are predicted to include growing maize, selling milk and small ruminants to town dwellers, and attempting to build up cattle herds. Policy measures should include (1) facilitation of food relief activities; (2) promotion of favourable terms of trade of livestock and milk for grain by improving market channels; (3) taking advantage of opportunities to export sheep from the southern rangelands; and (4) allowing cereal cultivation in ecologically sustainable sites.

Technical interventions should be focused in peri-urban locations for both pastoralists and farmers; this acknowledges logistical constraints for extension and that good ideas will be disseminated to outlying areas by Boran who visit market centres. Technical perspectives should prioritise (1) crop management to improve sustainable yields on appropriate sites, enhance crop diversity to reduce risks and promote crop–livestock interactions; (2) extend household-level grain store concepts to improve seasonal terms of trade; (3) enhance cow milk production through extension of acaricides, other health measures and improved calf management using grass hay and native legumes to reduce risk of calf mortality and thus lengthen the duration of lactations; (4) improve veterinary service for small ruminants; and (5) initiate options and incentives for the Boran to bank livestock capital.

For outlying communities, the drought-recovery phase is also the time to promote site-restoration activities, including burning and regulated charcoal production for bush control and facilitate access to camels for encampments to increase their ability to transport grain from markets. All supplies and services should be paid for by the Boran; this gives a good

test of their priorities. The Boran should be typically unwilling to pay using cattle sales at this time, however, so sales of small ruminants may have to be used more to generate funds.

Means to deal with the high-density phase could start around 1997; development tactics should complement strategies employed by the Boran. Some are similar to those in the drought-recovery phase such as growing maize and selling dairy products. However, others include a need to accommodate more cattle grazing and to reduce risks incurred by holding more cattle under more precarious environmental circumstances. Additional policy or procedures should include preparedness of agencies to (1) cope with increased likelihood of having to distribute food relief; (2) facilitate implementation of projects involving development or maintenance of water points and building grain stores funded by cattle sales; (3) initiate a major push to bank livestock capital; (4) ensure that drought reserves are capable of handling an adequate number of cattle given that a dry year occurs; and (5) market cattle to the highlands or for export. For activities (3) and (4) traders should be coordinated to help remove marketed cattle from the system. Technical perspectives should prioritise extension of appropriate grazing management plans tailored for particular *madda* under resource stress; consideration of improvements to drought reserves including distribution of water and grazing; and extension of improved methods of calf feeding management based on hay making and native legumes.

Assuming many initiatives had been implemented, the subsequent inter-drought cycle after 1997 should be less catastrophic than the 1992–97 one. In summary, interventions can be grouped according to the following objectives: (1) Food security is dealt with by encouraging maize production on suitable sites, opening regional markets, de-regulating producer prices and extending health services to livestock; (2) Risk mitigation is achieved in part by improving food security, but also by banking livestock capital, reclaiming drought reserves and stimulating offtake to fund community projects; (3) Livestock production and herd turnover should be facilitated by factors listed in item (2) because increased offtake during the high-density phase should reduce the likelihood of density-dependent effects on cow milk production and animal mortality; (4) Poverty alleviation over the short-term is facilitated by banking livestock capital and increasing livestock production and herd turnover; and (5) Risks of ecological unsustainability should be lessened by banking livestock capital, reclaiming drought reserves, using restoration methods and grazing management to increase grazing resources available to select *madda* and by improving food security which would lessen the need for people to cultivate. Effects of facilitating human emigration would not be felt for a number of years, but these would include improvements to food security, risk mitigation and poverty alleviation.

It is proposed that one intervention exceeds all others by having a positive impact on food security, risk mitigation, livestock production and poverty alleviation; this is banking livestock capital. It is referred to as the “keystone” intervention. The constraints for implementing this intervention include (1) potential distrust of banking by the Boran exacerbated by culture; (2) barriers that exclude illiterate people from using the banking system; (3) lack of enough bank branches in the area; and (4) factors such as inflation which are subject to national currency management. Even under conditions of moderate inflation, banking livestock capital could be an effective means of ensuring asset accumulation that is less dependent on ecological system dynamics.

The other interventions in total could have significant impact, but in some respects they are more difficult to implement widely than banking livestock capital. Constraints include (1) limited manpower and funds for extension and land-use monitoring; (2) inadequate access of development agents to key amounts of foreign exchange to procure veterinary supplies, spare parts and other necessities (this is despite the fact that range livestock are intended to be a major generator of foreign exchange); (3) difficulties in development agencies and government coordinating their efforts to affect policy changes and work together to solve important problems; and (4) difficulties that the national economy has in producing and distributing consumer goods. Projects perceived as important to the Boran can be paid for in local currency from livestock sales and this is not viewed as a major obstacle. The irony is that lack of substantial development impact is not due to a lack of technology or inappropriate resistance on the part of the pastoralists.

Efficient implementation of the development programme reported above requires that some routine information be collected concerning cattle herd dynamics, land use, range trend and felt needs of the community on an annual basis. This information could be quantitative or qualitative in nature and could be used to validate and/or improve upon ideas proposed in the theory of local system dynamics. Interpretation of range trend data, in particular, may be complicated by the cyclic pattern of cattle herd dynamics. Herbaceous cover dynamics may appear cyclic rather than linear and trends may be difficult to discern. Similarly, bush establishment may appear as an episodic phenomenon during the high-density phase of the cattle population.

Future research priorities largely involve sociology and economics. These could include the study of (1) banking livestock capital to recommend asset management strategies for pastoral households and the role banked funds could play in urban development; (2) human population growth and the fate of Borana emigrants; (3) the degree to which the traditional social order can cope with stress and eventual loss of labourers; and (4) implications of system change for vulnerable groups such as women and children. Adaptive research could be directed towards problems involving sustainable cereal cultivation. The need for traditional livestock research is relatively minor.

Finally, implications of research findings for 28 major themes are highlighted. These include equilibrational system features, effects of the Boran on the environment, system sustainability, biodiversity, conservation of indigenous livestock breeds, gender, livestock production, pastoral production efficiency, upstream versus downstream research, production interventions versus those which mitigate risks, evolution of dairy marketing and agropastoralism, collaboration between research and development agents and the value of systems science for research, development thinking and education.

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