Annals of Arid Zone 36(2): 79-96, 1997

Livestock Management in Dryland Pastoral Systems: Prospects and Problems

Victor R. Squires[1] and Ahmed Sidahmed[2]
[1]*Dryland Management Consultant, 497 Kensington Rd, Wattle Park, Australia 5066*
[2]*Technical Adviser, IFAD, Rome, Italy 00142*

Abstract: Livestock production from the drylands is quite important both in terms of the volume of product produced and in respect to the number of people dependent on livestock for their livelihood. Drylands support the full spectrum of production systems from commercial ranching in Australia, western USA, Mexico, Argentina and southern Africa through various gradations of crop-livestock systems in Africa and Asia to traditional nomadic and semi-nomadic subsistence systems. Almost everywhere, livestock production is undergoing rapid change in response to political, social, economic, environmental and demographic pressures. In this paper, we will outline the characteristics of various production systems, review their prospects and identify the problems and challenges facing them. We will assess the likely impact of global climate change and of the new technologies and the new economic world order. Finally, we will try to predict what the 21st century will be like for the millions of people whose livelihoods depend on the grazing by domesticated livestock.

Keywords: Livestock management, dryland, rangeland, feed, sustainability.

The world's arid and semi-arid regions are to be found on every continent except Antarctica. They are home to more than 1 billion people and support millions of livestock in both traditional (non-commercial) and commercial production systems (Tables 1 and 2).

FAO (1987) estimated the total dryland area in developing countries as around 14

Table 1. Drylands in developing countries within region, million hectares

Growth days	Africa*	Southwest Asia	Southeast Asia	Central America	South America	East Asia	Total
1-74	488.0 (17%)	72.6 (11%)	47.4 (5%)	62.3 (23%)	114.6 (6%)	27.7 (3%)	812.6 (11%)
75-119	231.8 (8%)	61.8 (9%)	54.9 (6%)	14.5 (5%)	142.8 (8%)	70.4 (7%)	586.2 (7%)
Total drylands	719.8 (25%)	134.4 (20%)	102.3 (11%)	76.8 (28%)	257.4 (14%)	98.1 (10%)	1388.8 (18%)
Total area	2878.1	677.4	897.6	271.6	1770.2	954.6	7449.5

*Excludes South Africa.
Parenthesis show per cent of total land area for each region, e.g., Africa.

Table 2. Human population in drylands in developing countries within regions (in million), 1975

Growth days	Africa	Southwest Asia	Southeast Asia	Central America	South America	East Asia	Total
1-74	33.1	15.9	46.1	8.5	9.3	N.A.	112.9
	(9%)	(12%)	(4%)	(8%)	(4%)		(6%)
75-119	37.8	24.3	101.1	3.7	20.4	N.A.	187.3
	(10%)	(18%)	(9%)	(3%)	(9%)		(10%)
Total	70.9	40.2	147.2	12.2	29.7	N.A.	300.2
drylands	(19%)	(29%)	(13%)	(11%)	(14%)		(15%)
Total area	380.2	136.3	117.7	106.6	215.8	N.A.	1956.6

Parenthesis show per cent of total land for each region, e.g., Africa (Source: FAO, 1989).

million sq. km, of which 6.8 million sq. km are at present critically overpopulated. Their human population is some 78 million in excess of their carrying capacity at the present low level of inputs (Fig. i). Because of the variability of these systems (in space and time) and the impact of external pressures, many are at risk of overexploitation and accelerated land degradation (Dixon *et al.*, 1989).

In this paper, we will outline the characteristics of these production systems, review their prospects and identify the problems and challenges facing them. We will assess the likely impact of global climate change, development of new technologies, and the new economic world order. Finally, we will try to predict what the 21st century will be like for the millions of people whose livelihoods depend on grazing by domesticated livestock.

Definition and Terminology

Several definitions were proposed for dryland areas (Sidahmed *et al.*, 1986). Generally, drylands are characterized by low, erratic and highly inconsistent rainfall levels. These are reflected in fluctuating and unpredictable levels of crop and livestock production. The main feature of "dryness", excluding the extremely arid and desert areas, is the negative balance between the annual rainfall and evapotranspiration rate. The choice of the definition will depend upon the purpose and therefore, a multitude of factors, such as moisture, radiation, gas exchange, temperature and recycling of nutrients.

The zones falling between 1-74 (arid) and 75-119 (semi-arid) growing days, will be the focus of the present discussion. These areas receive between 100 and 600 mm annual rain and the ratio of annual precipitation to potential evapotranspiration lies between 0.05 and 0.65 (UNEP, 1992). Given the broad definition of what constitutes dryland, it is not surprising that there is a great deal of variability in most of their physical and biological characteristics; amount of rainfall, length of the dry season, soil characteristics, and density of trees, fauna and micro-organisms. This variability in turn determines the types of human occupation and use.

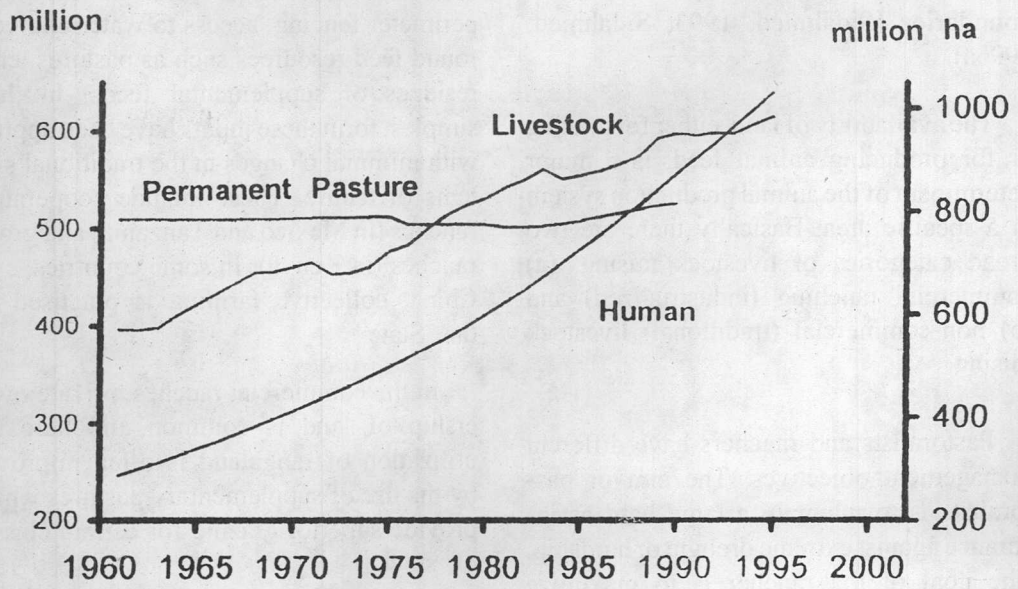

Fig. 1. Trends in human/livestock population and permanent pasture in 36 arid/semi-arid developing countries (Source: Sidahmed, 1996b). Note: Permanent Pasture: Lands used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing lands), FAO, 1993. Rangelands in the arid/semi-arid areas include permanent pastures and land not suited for other uses. Livestock: Cattle, goats, sheep and camels.

Rangeland Livestock Management

According to FAO (1996), drylands of the developing countries were raised by 59% of the cattle, 82% of the buffaloes, 41% of the sheep, 78% of the goats and 93% of the camels.

Systems of livestock raising

In general, drylands are grazed because they are not sufficiently productive or reliable to be cropped, which means that management must cope with low or unreliable production, complex semi-natural systems, large management units, and greater economic risk. Management systems are diverse, from intensive operations through large scale ranches to subsistence herding. Land use decisions must continually be made regarding conversion to cropland at the more productive margins of grazing lands and in relation to degradation in the less productive margins (Stuth and Stafford Smith, 1993).

Livestock production in the world's drylands is influenced by ecological, technical, institutional, economic (macro- and micro-economic) and political framework conditions (Sandford, 1983). These conditions

are interrelated and seldom have distinct boundaries (Sidahmed, 1993; Sidahmed, 1996a).

The availability of land, either for grazing or for producing animal feed, is a major determinant of the animal production system in a specific area. Basically there are two broad categories of livestock raising: (a) commercial ranching (industrialized) and (b) non-commercial (traditional) livestock raising.

Pastoralists and ranchers have different management objectives. The aim of pastoralists is to maintain a large herd as insurance against extreme drought or hardship. The goal of the rancher is to maximize money profit. Pastoralists try to reduce their work load as much as possible, ranchers try to maximize productivity of labor.

Most systems of raising livestock involve quite complex interactions of domestic livestock and the forage and water resources on which they depend (Butterworth, 1984). The most primitive of these systems was that of the migrational herding. Somewhat more complex migrationary systems are involved in nomadism and transhumance which utilize the seasonal production of grass and the available water in different grazing areas. Traditional nomadism is practised in many parts of Africa, the Middle East, central Asia and parts of South America. The more sophisticated modern equivalent of traditional nomadism is represented by the seasonal grazing practices found in parts of western United States and the Republic of South Africa.

Sedentary livestock production requires perimeter fencing, access to water and year round feed resources such as pastures, crop residues or supplemental feeds. In their simplest form these inputs have been applied with minimal changes in the traditional systems of tenure. These include cooperative ranches (in Mexico and Tanzania) and group ranches (in Kenya). In some countries, e.g., China, collective farming is practised by the State.

In the commercial ranches, private ownership of land is common and here the utilization of rangeland is often improved by the use of supplementary pastures which provide superior grazing for certain classes of stock.

Traditionally, livestock graze the low rainfall areas. However, with increasing population pressure, crop cultivation has encroached into the low rainfall areas and with improved veterinary services, livestock moved into the wetter areas (Sidahmed, 1993). At present many of the semi-arid regions are integrated crop-livestock systems.

Stock Composition

There are many factors which affect livestock distribution. Combinations of these factors produce different effects under different conditions (Temple and Reh, 1984). Environmental and biological factors can effect choice of livestock species. For example, cattle originating from temperate climates are adapted to a temperature range between 1° and 16°C, whereas, cattle originating from tropical climates can cope with temperatures in the range between 10° and 27°C (Williamson and Payne, 1965).

Cattle, sheep, goats, buffalo and camels are the principal livestock in drylands, although horses and donkeys are significant in some regions of central Asia and Africa. Generally, camels, sheep and goats are more suited to the drier regions than cattle or buffalo.

The best source material for estimates of the world's livestock population is the annual series of Production Yearbooks published by FAO (and stored in electronic form on Agrostat). These have been published for a sufficiently long time span to permit the dynamics of population change to be studied.

Detailed examination of the ecology, management and productivity of each of these species is beyond the scope of this paper. Readers may refer to specialist writings such as World Animal Science and various FAO publications.

However, it is worth noting that aspects such as adaptability (water requirements, salt tolerance, walking ability), utilization, and diet selectivity (rumen function) play an important role (Arnold and Dudzinski,1978; Squires, 1981). Different strata of vegetation may be utilized by different livestock species; some have complementary diet requirements, others overlap (Hofmann, 1988). Choice of species, therefore, is complex but is dictated as much by the constraints to production as by any other factor.

Constraints to Production

Pastoralism is an important system of production and the way of life of many people in the marginal drylands. Traditionally, pastoralism is centered on herding alone, or herding supplemented by shifting or rainfed crop cultivation to provide the herder with a livelihood. This system has been in deep crisis for decades in many areas. The crisis hits the subsistence economy, which is centered on animal production associated with cereal cropping and harvesting natural products. It also affects the social, political and cultural life of the people. Hiernaux (1995) has asked "is the crisis of pastoralism ecological or economic?" It must be concluded that the answer is complex because there are many constraints. Some of these can be overcome but others will remain intractable.

It is widely held that the main constraints to livestock production in drylands are:

- the long dry season (6-9 months) and an unpredictable rainfall pattern,
- inadequate and poor feed supply during the dry season,
- scarce water resources,
- low soil nutrient levels,
- poor genetic potential of local breeds,
- lack of marketing and product processing infrastructure,
- absence of livestock development policies,
- a wide range of animal diseases,
- uneven and in some areas lack of veterinary support services,
- poor administrative and institutional framework,
- remoteness, and
- inefficient transport facilities.

Generally, the potential for improved productivity has been substantially limited

by lack of capital, agricultural support services and an overall absence of appropriate technology responsive to the changing socio-cultural environment.

Current Issues Affecting Utilization and Sustainability in Drylands

The subsistence dryland systems are constrained by a wide range of resource management and social policy problems. The most prominent are climate variability and resource availability. The extent to which people are able to adapt depends on the flexibility of institutions, at all levels from those of governments to individual households. All too often, there is a tendency to lump the problems of the drylands into a single, or at best, a few categories. Clearly they are not.

Apart from the obvious effects of geographic region, there is the more important differentiation between structures or institutional organization. Different issues arise at each level. For example, at the household level, the issues might include: labor shortage, household size, food security, poverty; while at the village level, the issues might be: land (tenure, ownership and control), natural resources (fuelwood, water, wildlife), conflict resolution, population growth, local area planning. At the national level, the emphasis is on macro-economics and trends and on implementation of national policy. Each of these levels will have impacts on the drylands (Odada *et al.*, 1996).

Management of the natural resources is possible and much easier under social and biophysical stability. The parameters of change are recurrent short term (climate variability, population, markets, migration, etc.) and long term (global change - including population change, climate change and land use change). Although the magnitude and recurrence of change vary with different agro-ecological zones within and outside the dryland areas, the intensity of variation is more prominent in the dryland areas. Institutional and political systems also vary over time and space, partly driven by these factors.

Natural resource use and management are governed by perceptions of property rights applying to the resources in question. The key questions are "Who may or may not have access to the benefits the resources can supply, and on what conditions?" Property rights are thus the foundation of resource use, management and conservation. Tenure issues in most of the world's drylands are, in essence, concerned with property rights: their conceptual meaning, their operational aspects and their enforcement.

This aspect of land tenure, and in particular, common property rights was analyzed by IFAD (1995). The relevance of the classic Ricardian model of economic rent is argued (Fig. 2). Starting at the extreme extensive margin (point A), it can be seen that the economic value of the land and its related natural resources is so low as not to justify any management regime. That is, the per unit cost exceeds the social value. Such lands and their associated resources would be under a regime of open access. Therefore, any use, no matter how destructive, is less harmful than the costs necessary to preclude it. Between points A and B, there would be an open access regime over the land and its related resources. At point B, the economic value

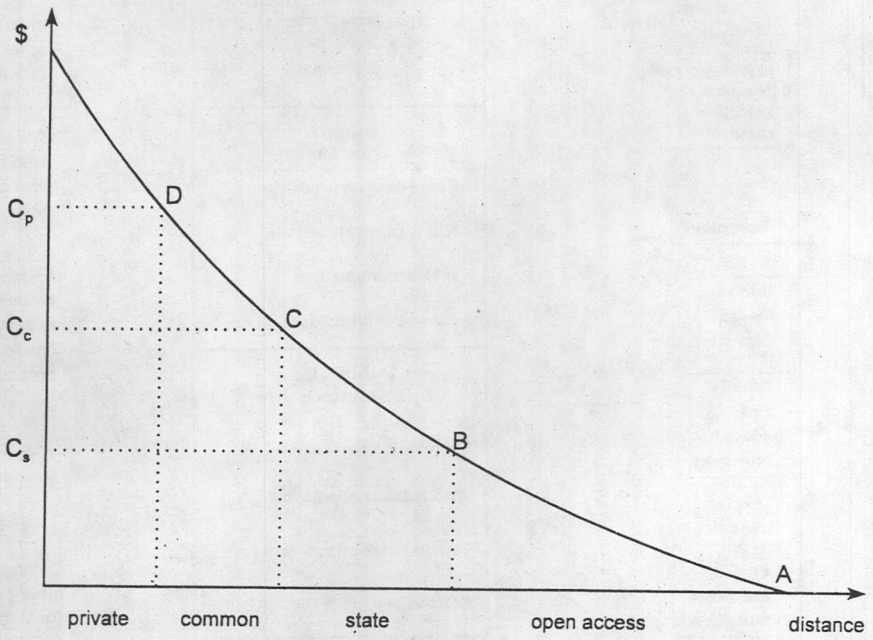

Fig. 2. A rent gradient and property regime according to the classic Ricardian rent gradient and location theory. Privately owned ranching land will generally be much more valuable than land at the extensive margin of the pastoral zone. The extensive margin is that zone beyond which virtually no investment in land or natural resources will occur. As one approaches the extensive margin, the commitment of labour and capital to a unit of land will fall to zero (Source: IFAD, 1995).

of the land as evidenced by the rent gradient, is sufficient to warrant some management. Here, society develops an institutional structure that is adequate to manage the benefit stream from the land and its related natural resources.

Moving closer to the urban center, the rent gradient increases as land becomes more valuable. The potential loss of benefits from the rather extensive and loose management regime of the state calls for something more elaborate and more attuned to local conditions. Here (beginning at point C), there is a group of user organizations to administer the natural resources under a common property regime. Finally, as the economic value of the resource increases further (at point D), the private property regime comes into play. The institutional choice flows from the inherent nature of the land, through the rent gradient, to the property regime of choice.

Environmental and sustainability issues have emerged over the past decade or so. These days, few ecological topics evoke more emotional reaction among concerned citizens of developed countries than the prospect of a drastic transformation of natu-

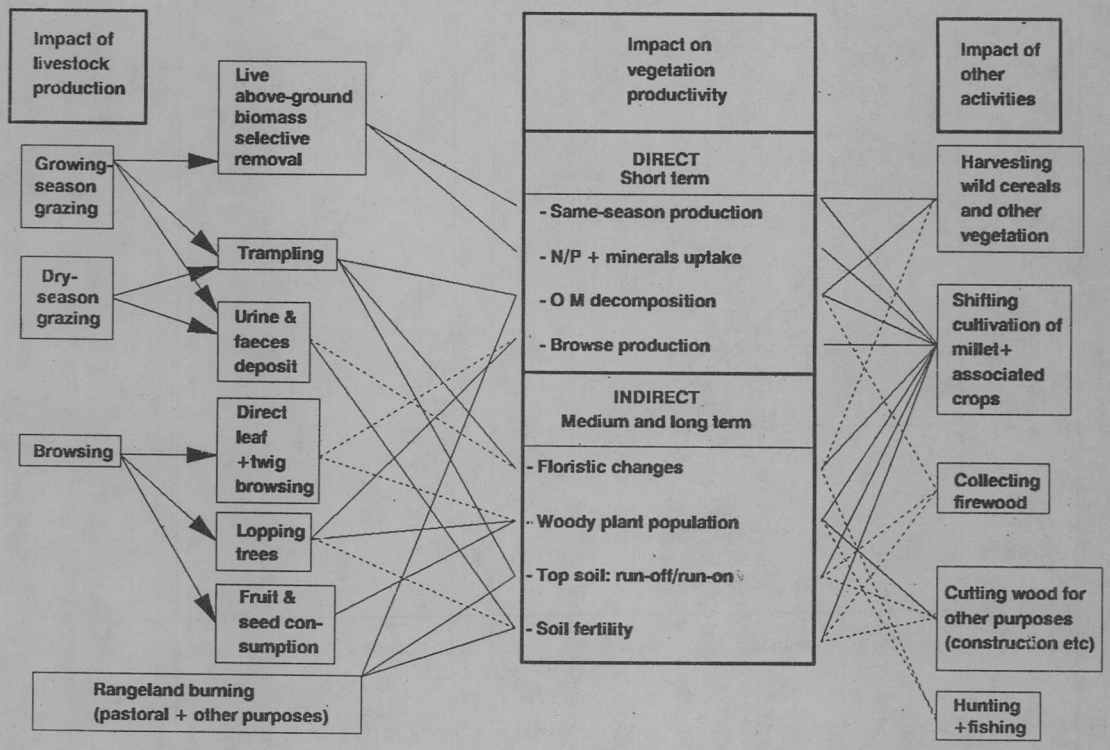

Fig. 3. Impact of the pastoral economy on environmental processes across much of Africa (Source: Hiernaux, 1995).

ral landscapes. The concept of sustainable agriculture (including livestock systems) is in the process of evolution and its operational content remains notoriously difficult to define. In the more marginal drylands, sustainable agriculture implies that a major emphasis must be placed on reducing the vulnerability of small farmers and herders to resource fragility and natural hazards (Jazairy *et al.*, 1992). Relieving the pressure on the natural resource base requires enhanced strategic interventions (Fig. 3).

The pursuit of environmental sustainability in marginal areas must be seen as a dynamic process requiring that the long term balance between population and carrying capacity is addressed through measures to relieve the pressure on fragile resources. The generation of "off-farm" income and the promotion of income- generating activities, including cottage-based industries, is one such way. Local Area Development Programmes (LADP) are being developed to facilitate this shift toward environmental sustainability and at the same time, address the serious problem of rural poverty (IFAD, 1996).

Several dryland countries have signed the UN Convention to Combat Desertification (CCD) which includes an obligation to formulate in a participatory fashion a national action plan to combat desertification (NAPCOD) addressing policy, in-

stitutional and technical factors with emphasis to community management of natural resources. In each country there is national focal point that guides the policy and legislative aspects of the NAPCOD through the CCD Steering Committee. Donor development agencies meet periodically to address how best to integrate LADP into the NAPCOD. One example is integration of the rangeland improvement programs into the overall framework of the CCD through the local area development proposals.

Science and Technology/Research on Knowledge Gaps

Research can be usefully differentiated into a) Upstream research (development of basic and strategic research) and b) Downstream research (participatory research involving adaptation, adoption and integration of local knowledge). Both are vital to secure the future of livestock raising in the drylands (ACIAR,1987).

On the international front, the Consultative Group for International Agricultural Research (CGIAR) has given the International Livestock Research Institute (ILRI) a global mandate for research to improve:

- animal performance through technological research and conservation of animal genetic diversity in developing regions,
- the sustainable productivity of major livestock and crop-livestock systems,
- the technical and economic performance of the livestock sector, and
- the development, transfer and utilization of research-based technology by national programs and their client farmers.

ILRI has identified a number of key themes for research (Table 3). Initially (1995-1998), the research focus will be on sub-Saharan Africa, and will gradually extend to Asia, Latin America, North Africa and West Asia (ILRI, 1996).

ILRI's priority programs (Table 3) emphasise integration of livestock research with other key global issues such as biodiversity (conservation and characterization of animal and forage genetic resources), climate change, desertification control and ameliorating the effects of drought.

Research directions for the 21st Century

Bioengineering is a potentially useful technology which could do much to improve livestock production in the next century. Disease resistance, greater adaptability to climate, and better feed conversion are just a few of the ways in which livestock producers in the drylands might benefit. Coupled with new feed processing technologies, better transport, communications, veterinary health (and other advisory services) and information flow, the future for livestock producers will be brighter.

Future Challenges

Pastoral systems are often considered to be relatively unproductive, with poor breeds of animals (often poorly fed and badly managed) present in such large numbers that serious rangeland degradation is unavoidable. The large herds are viewed as the result of the pastoralists' irrational attachment to their animals, with prestige and status, rather than economic gain, allegedly being the pastoralists' main concerns (Sandford, 1983).

Table 3. Research priorities identified by ILRI (Source: ILRI, 1996)

Research area	SE Asia	South Asia	LAC	WANA	SSA
Productivity/Sustainability of crop-livestock systems	*[1,2]	*[2]		*	*
Plantation/tree/livestock systems	*	*	*		
Natural resource management		*		*	*
Animal breed improvement	*[3]	*[3]			
Genetics of disease resistance	*				
Livestock biodiversity		*	*	*	*
Animal health/diagnostics/epidemiology/integrated control	*				
Systems analysis/ methodologies		*	*		
Livestock policy analysis		*	*	*	*
Feed utilisation		*	*	*	*
Forage biodiversity			*	*	

1. Uplands; 2. Lowlands; 3. Buffalo.

If pastoralists seem unduly attached to unproductive animals, or to anachronistic economic activities or social organizations, this is the result of the environment in which they live, and of the objectives of their society. While there are some intangible 'romance' factors associated with pastoral life, it is more often hard, insecure and uncomfortable.

In many pastoral systems, land is a scarce and shrinking resource. Under this pressure, the objective of a pastoral society is to support more people per unit area of arid land and to give them as much security as possible, by maximizing food production per hectare. Most pastoralists achieve these multiple goals by increasing the production and consumption of milk, which is far more important for them than the consumption and sale of meat. This objective, as well as the risk aversion strategy of pastoral systems, have been overlooked (Scoones, 1995). Superficial comparisons with the western-type beef ranching systems have led to false conclusions about the efficiency and productivity of African pastoral systems (Cossins, 1985; Ellis and Swift, 1988; Behnke *et al.*, 1993).

The productivity of pastoral systems has usually been measured in terms of market take-off, completely ignoring the food used for human subsistence. The animal protein and gross energy produced annually from each hectare are more appropriate comparative indices of productivity (Cossins and Upton, 1987).

The new paradigm for drylands and implications for management

According to the equilibrium model, which underlies conventional range science, upon displacement of succession by disturbance, the rangeland returns to its former equilibrium. For a number of years now, serious questions have been raised about the wisdom of the conventional range management thinking (Sandford,1983; Westoby *et al.*, 1989; Mentis *et al.*, 1989; Roe 1989). Two concepts have dominated the thinking regarding ecology and land use: (1) that ecosystems are equilibrial systems and (2) that people are an outside source of disturbance. Dryland systems are more appropriately viewed as non-equilibrial systems within which people form an integral part (Stafford Smith, 1996). When disturbed, such systems are likely to adopt an entirely new stable or quasi-stable state. Another characteristic of non-equilibrial systems is that they oscillate continually due to their own internal dynamics. These oscillations may be regular (limit cycles) or irregular (chaotic cycles).

These characteristics of non-equilibrial systems have important management implications. In effect, non-equilibrial degraded systems do not necessarily return to their previous state when the source of the disturbance is removed, and, in most cases, it might not be possible to return them to their original condition. Furthermore, it means that one prescription will not work on all drylands. The previous history and present disturbance regime will determine the outcome of management systems (Solbrig, 1993).

Non-equilibrium systems are inherently unpredictable. The same disturbance can create one state in one instance and a very different state in another. Sudden, unpredictable and perhaps irreversible change is frequently seen in drylands when drought and livestock interact to over-utilize rangelands. The principal arguments in favor of the new paradigm (based on the non-equilibrial rather than the equilibrial paradigm) were set out in Behnke *et al.* (1993) and Stafford Smith (1996). Studies with non-equilibrial systems (Nicolis, 1991) indicate that their behavior is very different from that of equilibrial systems. As further work has been done, it is recognized that even a two-part classification may be too simple to cover the complexity (Table 4). Here, disequilibrial dynamics are matched with those which respond in a classic equilibrial way and those which are designated quasi-equilibrial (Galvin and Ellis, 1996). If, as seems increasingly likely, most drylands are non-equilibrial systems, then changes are as likely to be improvements as deteriorations. Non-equilibrial systems will require more, rather than less, human investment to understand and manage them (Solbrig, 1993).

There is now a new paradigm about research and extension (ACIAR,1987). The classical approach of technology transfer no longer works. Action research or other variants where the farmer or herder is involved as a co-researcher have emerged (Fig. 4). The value of local indigenous knowledge has at last been recognized. There is a need to educate the researchers and the educators (Squires and Tow, 1991)

Table 4. A classification of climate-land use interactions for sub-Saharan rangelands, based on rainfall patterns and human socio-ecological strategies (Source: Galvin and Ellis, 1996)

	East Africa: Bimodal rainy season	**Southern Africa: Long monomodal rainy season**	**West Africa: Short monomodal rainy season**
DISEQUILIBRIAL DYNAMICS	Turkana, northern Kenya	Kalahari	Sahel
Rainfall: Low (100-400 mm/y)	**Land use**: Nomadic Pastoralism	Land use: Hunting, Gathering, Pastoralism	Land use: Transhumant, Pastoralism, Agro-pastoralism
CV: High (0.35-0.65) Droughts 2 in 10 years			
Long Term Shifts: 20-30 year cycles	**Challenges**: Drought Resilience		**Challenges**: Drought Resilience, Soil Fertility
QUASI-EQUILIBRIAL DYNAMICS	Borana, southern Ethiopia	Lowveld, South Africa	Sahel - Sudan
Rainfall: Moderate (400-800 mm/y)	**Land use**: Pastoralism	Land use: Hunting, Agro-pastoralism	**Land use**: Agro-pastoralism
CV: Moderate Droughts 1 in 10-20 years			
Long Term Shifts: 10-20 year cycles	**Challenges**: Drought Resilience		**Challenges**: Soil Fertility, Grazing, Orbits
EQUILIBRIAL DYNAMICS	Maasai, Ngorongoro Conservation Area	Highveld, South Africa	Sudan
Rainfall: High (>800 mm/y)	**Land use**: Transhumant Pastoralism	Land use:	**Land use**: Subsistence and Commercial Agriculture
CV: Low Droughts very rare	**Challenges**: Livestock Disease		

Global change

It is increasingly recognized that human-induced land-use change and land-cover change will probably represent the most important component of environmental change now and for some decades to come (Vitousek, 1994). Land-use change (mostly studied by social scientists) and land-cover change (mostly studied by ecologists) are connected human activities that directly alter the physical environment (Meyer and Turner, 1992) and affect the sustainability of land-use systems through their impact on biological diversity and ecosystem downwind and downstream of

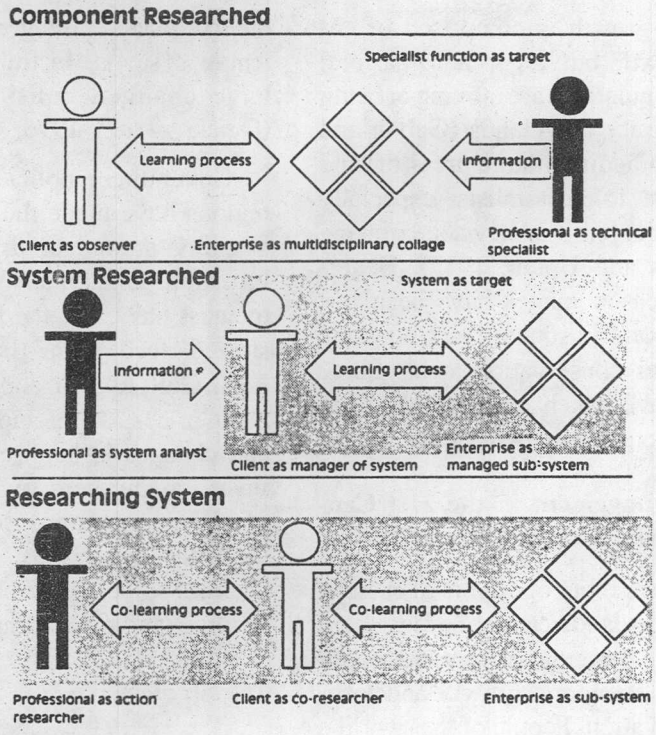

Fig. 4. The role of extension workers, researchers and the client (principally the herder) can be viewed in different ways. There is growing recognition that the client is a co-researcher and that capturing appropriate indigenous knowledge is the key to success in many development project (Source: Squires and Tow, 1991).

affected areas (Leemans and Zuidema, 1995).

Climate change, as one part of the syndrome of global change, has the potential to impact significantly on pastoralism as temperatures rise and rainfall patterns change (Odada *et al.*, 1996). Other macro-scale changes include globalisation of the world market and transition to the market economy.

People of the dryland face many challenges. Traditional pastoral resource strategies in non-equilibrium ecosystems are characterized by diversification, flexibility and opportunism, facilitated by decentralized decision making (usually occurring at the household level). Historically, pastoralists adapted well to climate variability (Galvin and Ellis, 1996). However, current examples of successful human-ecological adaptation to climate change and variability are few because the traditional land use patterns of pastoralists have been altered dramatically. Many pastoralists in many places are constrained by human population growth and a decreasing area of usable land.

Population growth is comprised of endogenous growth but other agro-pastoral and farming populations are moving or being forced into former rangelands (Galvin and Ellis, 1996). In addition large areas of land have been lost to pastoralists, especially their "crucial centers" or keystone grazing areas (Cossins and Upton, 1987). Better-watered dry season ranges have been lost to agriculture, and in some places, to game parks and other conservation areas. Some pastoralists have taken up agriculture to meet their increasing food demands.

Livestock Management in the 21st Century - A Vision

There are a number of drivers of change. People in the drylands cannot be insulated from them. The principal drivers are: population growth, economic growth and technological innovation. People of the world's drylands will need to change. The changes can be summed up under three headings:

Less dependence on subsistence

Rangeland resources are becoming scarce, and conflicts are increasing.

Households use rangeland for different purposes, and rely on these activities to a different extent. Most households use rangelands for more than one purpose, but their dependence on each activity differs. Low-income groups depend on a greater variety of rangeland resources than high income groups. High-income groups are primarily interested in livestock production. Activity patterns have changed substantially because of institutional arrangements governing access and physical resource availability. The major rangeland resources (forage, land, water, wildlife, fuelwood, medicinal plants) are governed by different tenure systems. Institutional arrangements have changed considerably over time (Odada *et al.*, 1996; Meyerhoff, 1991).

Government policies in many dryland regions have made the livestock sector artificially attractive, drawing most of the investible funds into livestock. This attractiveness has taken the form of heavily subsidized feed grains (barley) in the Middle East, Gulf Region and North Africa, high meat prices, a lax and lenient tax system and changes in land tenure systems which favor a few herd owners at the expense of the traditional subsistence herders (Salzman and Galaty, 1990). All of these changes point to less reliance on subsistence farming and/or herding as a way of life.

More commerce

Household economics are changing rapidly. In many pastoralist societies a direct correlation could be made between wealth and livestock ownership; wealthy households owned large herds/flocks, while poorer households had few stock. Farming has never been associated directly with wealth, instead it contributed to a household's subsistence. This is not necessarily so today; other sources of income have become just as important as livestock. Ready cash is increasingly being sought by all members of the community. Diversification in business is rapidly occurring.

Fewer beneficiaries to provide for

Today, few dryland households can afford to entirely rely on rural natural resources. Almost all rural households have access to non-agricultural employment or cash-generating activities such as cottage

industry (IFAD, 1995). Non-agricultural income is less drought-susceptible, and enhances household income. However, the priority given by households to such activities transfers family labor, the most productive labor being allocated to non-agricultural activities and away from the livestock sector. Another factor is the smaller family size, which affects availability of labor, but at the same time, reduces the numbers of people directly dependent on the drylands.

Two factors have made the livestock sector less attractive for the small herd/flock owner: increasing cost of inputs (and the need to have ready cash), and economies of scale. Because of increasing resource scarcity, the costs of livestock raising have increased over time. Traditional, free-exchange mechanisms have become more rare (Young and Solbrig, 1993).

Economies of scale are also critical. Large herd owners have easy access to credit and other factors. Unlike small herd owners, they are consequently able to separate their own consumption and production. Small herd owners depend on direct products from their herds and using herds as a store of wealth, selling only in time of need.

Conclusions

Predicting rural trends is fraught with uncertainty. Competitive forces are at play, not only in the international markets but within national boundaries. There are competing land uses between livestock production and cropping, and between forms of livestock production as cattle give way to sheep and goats and camels are fast losing their competitive advantage. Livestock producers are often squeezed to a point where resource degradation is inevitable. Often, population pressure and poverty coincide, such as in many pastoral areas. These shifts call for a different set of institutions, markets and policies. They also call for the development and adaptation of new technologies to make livestock environmentally more benign - the scope is enormous and so is the task.

Consumer preferences for food and non-food items have already changed substantially and there is intense competition for the consumer dollar. In the more affluent markets of the newly-emerged economies, there is an increasing demand for red meat. Higher import quotas of cheaper frozen(or chilled) meat has put pressure on local producers. National governments have responded by providing heavy subsidies on feed grains or providing other cash incentives which have completely changed the traditional way of livestock raising (Chatty, 1986). The desire for food self sufficiency has encouraged many governments to develop former rangelands as croplands.

Government policies in many countries are also aimed at rainfed agricultural productivity and incomes to match those of other sectors in the economy. Structural changes, many directly dependent on government intervention and the development of price support systems funded by revenue from other sectors, have been put in place.

Dryland pastoral societies are becoming progressively marginalized in political, cultural and economic terms. Although linked to national economies and through them to world markets, many dryland people have little control over their destinies. Many development, land-use and trade policies,

for example, are formulated without considering their implications for the people inhabiting the world's drylands. Yet the influence of these policies can be dramatic. The situation is complicated by the relatively slow speed at which dryland ecosystems reveal their responses to policy (Young and Solbrig, 1993).

The pastoral industries face an increasingly competitive future but they have a long history of meeting challenges of drought, recession and political upheaval. The next challenge is sustainability. Considerations such as the permanence of the resource base have begun to emerge, especially in response to the signing by many countries of the International Conventions on Climate Change, Desertification and Biodiversity.

The decade of the 1990s has been a period of advocacy of sustainability and several key measures have been put in place via International Conventions (see above). The policy options have been spelled out (Sidahmed, 1992;1993; Hassan, 1996). The challenge for the opening decades of the twenty-first century is to implement these measures. Finding the balance between increased food production and the preservation of the world's natural resources remains a major challenge. It is clear that food will have to be produced at less cost to the natural resource base than at present.

References

ACIAR. 1987. *Agricultural Systems Research for Developing Countries* (Ed. J.V. Remenyi). ACIAR Proceedings No.11: Australian Centre for International Agricultural Research, Canberra, 189 p.

Arnold, G.W. and Dudzinski, M.L. 1978. *Ethology of Free-ranging Domestic Animals*. Elsevier, Amsterdam.

Behnke, R.H. Jr., Scoones, I. and Kerven, C. (Eds.) 1993. *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas*. Overseas Development Institute, London.

Butterworth, M.H. 1984. Animals in relation to land use. In *Development of Animal Production Systems* (Ed. B. Nestel). Vol 2A, pp. 15-32. World Animal Science, Elsevier, Amsterdam.

Chatty, D. 1986. *From Camel to Truck: The Beduoin in the Modern World*. Vantage Press, New York.

Cossins, N.J. 1985. The productivity and potential of pastoral systems. *ILCA Bulletin* 21: 10-15.

Cossins, N.J. and Upton, M. 1987. The Borana pastoral system of southern Ethiopia. *Agricultural Systems* 25: 199-218

Dixon, J.A., James, D.E. and Sherman, P.B. 1989. *The Economics of Dryland Management*. Earthscan Publications, London.

Ellis, J.E. and Swift, D.M. 1988. Stability of African pastoral ecosystems: alternate paradigms and implications for development. *Journal of Range Management* 41: 450-459

FAO 1987. Improving productivity of dryland areas. *COAG 9th Session*, FAO, Rome.

FAO 1996. *AGROSTAT*. Statistics Division, FAO, Rome.

Galvin, K. and Ellis, J.E. 1996. Climate pattern and human socio-ecological strategies in the rangelands of sub-Saharan Africa. In *Global Change and Subsistence Rangelands in Southern Africa: The Impacts of Climatic Variability and Resource Access on Rural Livelihoods (Eds. E. Odada, T. Otlogetwe, M. Stafford Smith and J. Ingram). GCTE Working Document No. 20.*

Hassan, H. 1996. *Natural Habitats and Environmental Management in Drylands* (4th draft, March 6, 1996), ENVLW, World Bank, Washington (mimeo).

Hiernaux, P. 1995. *The Crisis of Sahelian Pastoralism: Ecological or Economic*? ILCA, Addis Ababa.

Hofmann, R.R. 1988. Anatomy of the gastrointestinal tract. In *The Ruminant Animal: Digestive Physiology and Nutrition* (Ed. R. C. Church), pp. 14-23. Reston Books, New Jersey.

IFAD 1995. *Common Property Resources and the Rural Poor in sub-Saharan Africa*. IFAD, Rome.

IFAD 1996. *International Forum on Local Area Development Programmes in Implementing the CCD*. June 5-7, 1996. FAO, Rome.

ILRI 1996. *Building a Global Research Institute*. ILRI, Nairobi.

Jazairy, I., Alamgir, M. and Panuccio, T. 1992. *The State of World Rural Poverty: An Inquiry into its Causes and Consequences*. IFAD/New-York University Press, NY.

Leemans, R. and Zuidema, G. 1995. Evaluating changes in land cover and their importance for global change. *Trends in Ecology and Evolution* 10: 76-81.

Mentis, M.T., Grossman, D., Hardy, M.B., O'Connor, T.G. and O'Reagan, P.J. 1989. Paradigm shift in South African range science, management and administration. *South African Journal of Science* 85: 684-687.

Meyer, W.B. and Turner, B.L. 1992. Human population growth and global land-use/cover change. *Annual Review of Ecology and Systematics* 23: 1-14.

Meyerhoff, E. 1991. *Taking Stock: Changing Livelihoods in an Agropastoral Community*. African Centre for Technology Studies, Nairobi.

Nicolis, G. 1991. Non-linear dynamics, selforganization, and biological complexity. In *Perspectives on Biological Complexity* (Eds. O.T. Solbrig and G. Nicolis), pp. 7-49. IUBS, Paris.

Odada E., Otlogetwe, T., Stafford Smith, M. and Ingram, J. (Eds.) 1996. Global change and Subsistence Rangelands in Southern Africa: The Impacts of Climatic Variability and Resource Access on Rural Livelihoods. *GCTE Working Document No. 20*.

Roe, E.M. 1989. Six myths about livestock rangelands development south of the Sahara. *Rangelands* 11(5): 217-221.

Salzman, C. and Galaty, J.G. 1990. *Nomads in a Changing World. Institut Universitario Orientale, Naples.*

Sandford, S.1983. *Management of Pastoral Development in the Third World*. Wiley, New York.

Scoones, I. 1995. *Living with uncertainty: New directions in pastoral development in Africa*. International Institute for Environmental Development (IIED) International Technology Publications Ltd., London, UK, pp. 103-105.

Sidahmed, A.E. 1992. Sustainable rangelands in the Near East and North Africa. *Rangelands* 14(4): 201-205.

Sidahmed, A.E. 1993. Institutional and economic framework conditions for livestock development in developing countries and their interrelationships. In *Livestock Development in Developing Countries: Development Issues and Research Needs* (Eds. J. Richter, K.J. Peters and H. Franzen). Centre for Tropical and Subtropical Agricultural Research/German Foundation for International Development.

Sidahmed, A.E.1996a The rangelands of the arid/semi-arid areas: Challenges and hopes for the 2000s. Key note address paper to Symposium D: Rangelands (inventory, monitoring, management and improvement). *The International Conference on Desert development in the Arab Gulf Countries*. Kuwait Institute for Scientific Research (KISR), Kuwait, 23-26 March 1996.

Sidahmed, A.E. 1996b. Restocking destitute pastoralists: Issues on post-disaster rehabilitation. Presented to the Development Studies Association Annual Conference: *Symposium on Restocking*, Bridges Hall, University of Reading, UK; 18 - 20 September 1996.

Sidahmed, A.E., Morton, R.H., Timom, V. and Norse, D. 1986. *Improving livestock productivity in dryland areas*. Committee on Agriculture, FAO/COAG 1986 Resource Paper. FAO, Rome.

Solbrig, O. 1993. Ecological constraints to savanna land use. In *The World's savannas: Economic Driving forces, Ecological Constraints and Policy Options for Sustainable Land Use* (Eds. M.D. Young and O.T. Solbrig). MAB Volume 12, pp. 21-44. UNESCO/ Parthenon Publishing, Paris.

Squires, V.R. 1981. *Livestock Management in the Arid Zone*. Inkata Press, Melbourne.

Squires, V.R. and Tow, P.G. 1991. *Dryland Farming: A Systems Approach*. Oxford University Press, Melbourne.

Squires, V.R. and Vera, R.R. 1992. Commercial beef ranching in tropical and semi-arid zones. In *Beef Cattle Production* (Eds. R. Jarrige and C. Beranger) Vol. 5. World Animal Science, Elsevier, Amsterdam.

Stafford Smith, M. 1996. Management of rangelands: Paradigms at their limits. In *The Ecology and Management of Grazing* (Eds. J. Hodgson and A.W. Illius), pp. 325-356. CAB, London.

Stuth, J.W. and Stafford Smith, M.1993. Decision support for grazing lands: an overview. In *Decision Support Systems for the Management of Grazing Lands* (Eds. J.W. Stuth and B.G. Lyons). MAB Series Volume 11: pp. 1-35. UNESCO/Parthenon, Paris.

Temple, R.S. and Reh, I. 1984. Livestock populations and factors affecting them. In *Development of Animal Production Systems* (Ed. B. Nestel). World Animal Science Vol. 2. Elsevier, Amsterdam

UNEP 1992. *World Atlas of Desertification.* UNEP/Edward Arnold, London.

Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. *Ecology*. 75: 1861-1876.

Westoby, M. Walker, B. and Noy Meir, I. 1989. Opportunistic management for rangelands not at equilibrium *Journal of Range Management* 42: 266-274.

Williamson, G. and Payne, W.J.A. 1965. *An Introduction to Animal Husbandry in the Tropics.* (2nd edition) Longmans, London.

Young, M.D. and Solbrig, O.T. (Eds.) 1993. *The World's Savannas: Economic Driving Forces, Ecological Constraints and Policy Options for Sustainable Land Use*. MAB Volume 12, pp. 21-44. UNESCO/Parthenon Publishing, Paris.