

The rangelands of the arid/semi-arid areas: Challenges and hopes for the 2000s¹

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Abstract

Do we need to worry about the rangelands in the arid and semi-arid areas? Is there hope for these resources in the year 2000 and beyond? Is it valid to assume that the world's marginal rangelands will survive the extraordinary pressures which started around the mid-1950s as a result of the sharp increase in human population density? What can modern technologies bring to these areas, other than disaster and over-use? Nowadays, domestic animals are trucked to the remotest corners of the earth and plants that used to flourish under very irregular and scanty rain hardly get a chance to germinate. The seed banks are depleting rapidly, and the seasonally-rich grazing areas are turning irreversibly into barren lands. *These are the cries of the times, and the agonies of the helpless.* However, nature has its own defense mechanisms and strategies which it has maintained throughout the history of our planet.

This paper explores the fore-mentioned issues from a historic and statistical perspective. Issues relating to the validity and long-term sustainability of approaches to monitor and manage the extensive rangelands in a changing world are substantiated and discussed. Attention is also given to the socio-economic and technical relevance of *high tech* and conventional approaches towards understanding the dynamics of vegetation and livestock, the consumption habits of graziers, and the market forces. Consideration is given to the balance between natural and man-made defenses and strategies and responsibilities at national and regional (e.g., GCC) levels are explored, proposed and/or recommended.

Keywords: arid, semiarid, dryland, rangelands, degradation, pastorals, resilience, drought, rainfall, Internet, indigenous knowledge, imagery satellite

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Introduction

The rangeland³ provides one of the most important resources of the world's arid and semi-arid (drylands) areas. Historically speaking, the rangeland was the center of attention for its dwellers, who accumulated significant knowledge and experience in managing and living in conditions of uncertainty. The traditional pastoral communities in the Arabian Peninsula, Africa and elsewhere, were better managers of the fragile environments of the arid and semi-arid areas. For thousands of years, the nomads managed to adjust their strategies according to the rainfall pattern, and avoid muddy soils and fly-infested pastures. They knew that the local vegetation had natural defense mechanisms for combating long spells of drought and other climatic patterns. By following cyclic and migratory strategies and other opportunistic husbandry practices, the nomads were able to prevent the extinction of their livestock herds and flocks and maintain the bio-diversity of the local breeds.

Modern advances in technology, transport and communications brought about rapid changes which affected the natural resources, as well as the cultures and life-styles of the inhabitants of the dryland areas. The rangelands, which constitute a major renewable resource in a highly vulnerable, diverse and difficult environment, were most affected by such change. Governments, donors and development organizations tried to manage and develop the unpredictable resources through modern concepts such as ranching, fencing, the establishment of deep bore water points and settlements of the mobile herders, but with little success. Most of the endeavors failed to achieve any advantage over traditional practices which were capable of coping with annual fluctuations between the dry and wet seasons, and the natural calamities periodically afflicting these areas. This was reflected in wrong interpretation, panic and, in many occasions, pessimism, when dealing with the long droughts that hit sub-Saharan Africa during the '70s and '80s. The international community devoted considerable resources to combat what was described as 'the annual advance of the Saharan desert', but to no avail.

This paper reviews the issue of rangeland degradation in the dryland areas and proposes recommendations to assure optimal use and conservation of these resources in the year 2000 and beyond.

The Rangelands of the Arid/Semi-Arid Areas: A Review

Arid/semi-arid areas

Arid and semi-arid areas are defined as areas falling within the rainfall zones of 0-300 mm and 300-600 mm, respectively (FAO, 1987). Because of the short growing periods (1-74 and 75-119 growing days, respectively), these areas are not suitable for cultivation. Rainfall patterns are unpredictable and are subject to great fluctuations. One-year droughts are more frequent than multi-year droughts. The occurrence of drought is more frequent in the arid (lower rainfall) areas than in the semi-arid zones. For example, according to Ellis (1992), drought occurs every five years in the Turkana District of Kenya (200-500 mm annual rain), whereas it occurs every 8-12 years in the Massai region (300-700 mm rainfall). Severe multi-year droughts in Turkana decimated half the livestock and led to the temporary migration of 20% of the human population (Ellis, 1995). In contrast, single-year drought does not cause livestock mortality.

Historically, the rangeland-dominating arid and semi-arid areas provided primary products (grasses, legumes and shrubs) which were converted into animal protein. Use of the resources for other purposes, such as fuel

³ Rangeland is defined by the Society for Range Management (SRM) as the "land on which the native vegetation, predominantly grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing use." Includes lands revegetated naturally or artificially to provide a forage cover that is managed like native vegetation. Rangeland includes natural grasslands, Savannah, shrublands, most deserts, tundra, alpine communities, coastal marshes and meadows. According to the World Research Institute (WRI), rangelands are: extensive tracts of arid/semi-arid lands that are essentially unsuited to rainfed cultivation, industrial forestry, protected forests or urbanization.

and building material, intensified with the increase in human population and with sedenterization. These rangelands maintained an ecological balance as a result of the natural defensive mechanisms typical of uncertain and highly erratic climates. Seasonal fluctuations influence the concentration and mix of herbivores, and multi-year droughts reduce the number of animals.

An assessment of the dynamics of the drylands requires long-term data collection. However, as a result of the information available, it has been possible to conclude with a reasonable degree of certainty that plant biomass is greatly influenced by fluctuations in rainfall (Ellis, 1992, 1995; Scoones, 1995) (Figure 1).

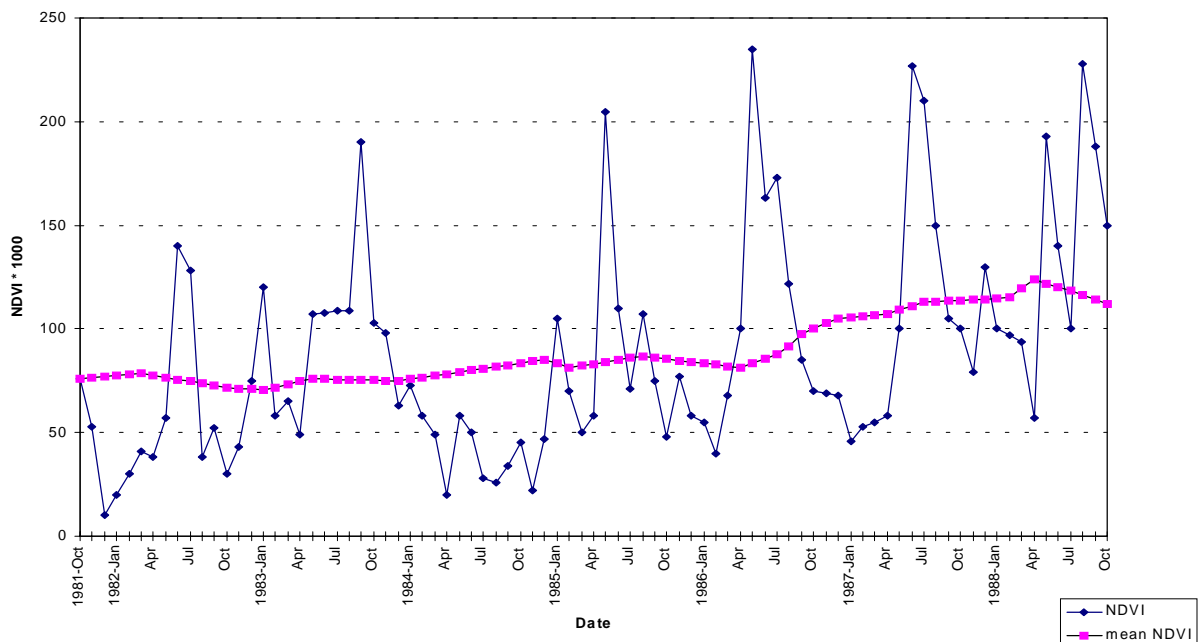


Figure 1. *Monthly and running mean normalized difference vegetation index (NDVI)*

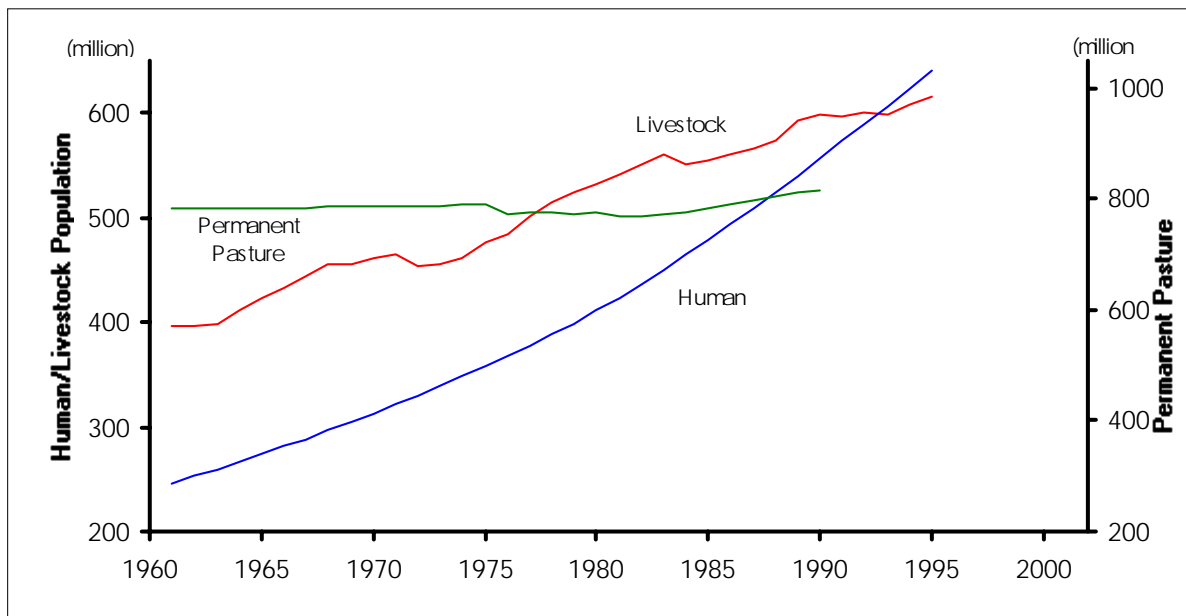
Source: Nysonyoka Territory, Turkana District Kenya (Ellis, 1995, p. 39)

Recovery continues even after severe drought, in spite of the short-term influences of seasonal and one-year droughts until the onset of another multi-year drought. Also, it is an accepted fact that the influence of this type of biomass variation is typical of the drylands environment and is much stronger than changes induced by livestock. Such a pattern is common to most arid and semi-arid areas (e.g., Africa), except where government policies (and herders income) allow for continuous use of the rangelands through the support of external factors (e.g., trucking water, year-round availability of subsidized grain, stable livestock value compared with the changing value of the local currencies). The latter is common in the Near East and North Africa countries.

Historic data (1960s to present) collected from 36 dryland countries (Annex 1) using AGROSTAT estimates (FAO, 1996) were used in comparing the trend in livestock and human population with the changes in the permanent pastures (Figure 2). Area-wise, the permanent pasture remained unchanged over three decades, whereas the human population increased 2.6 times. In spite of some fluctuations, livestock numbers increased from 400 million head in 1961 to 600 million in 1995. The important conclusion reached from observing the trends over three decades is that arid/semi-arid rangelands are currently subject to heavier grazing pressure than was the case thirty years ago.

The observations derived from FAO's statistics are supported by extensive surveys carried out on livestock populations in the drylands and wetlands of Mali, Niger, Nigeria, Mali and Sudan (Wint and Bourn, 1994). The analysis of the results point to a strong relationship between human activity (density and cultivation) and the intensity of livestock production activities. However, in spite of progressive settlements of pastoralists, and changes

in herd composition, breed and animal size, the movement from extensive systems to intensive (zero grazing) systems has always been slow (FAO, 1994, see ref.), whereas the supply of natural feed resources has remained static or increased very slowly (Figure 2).



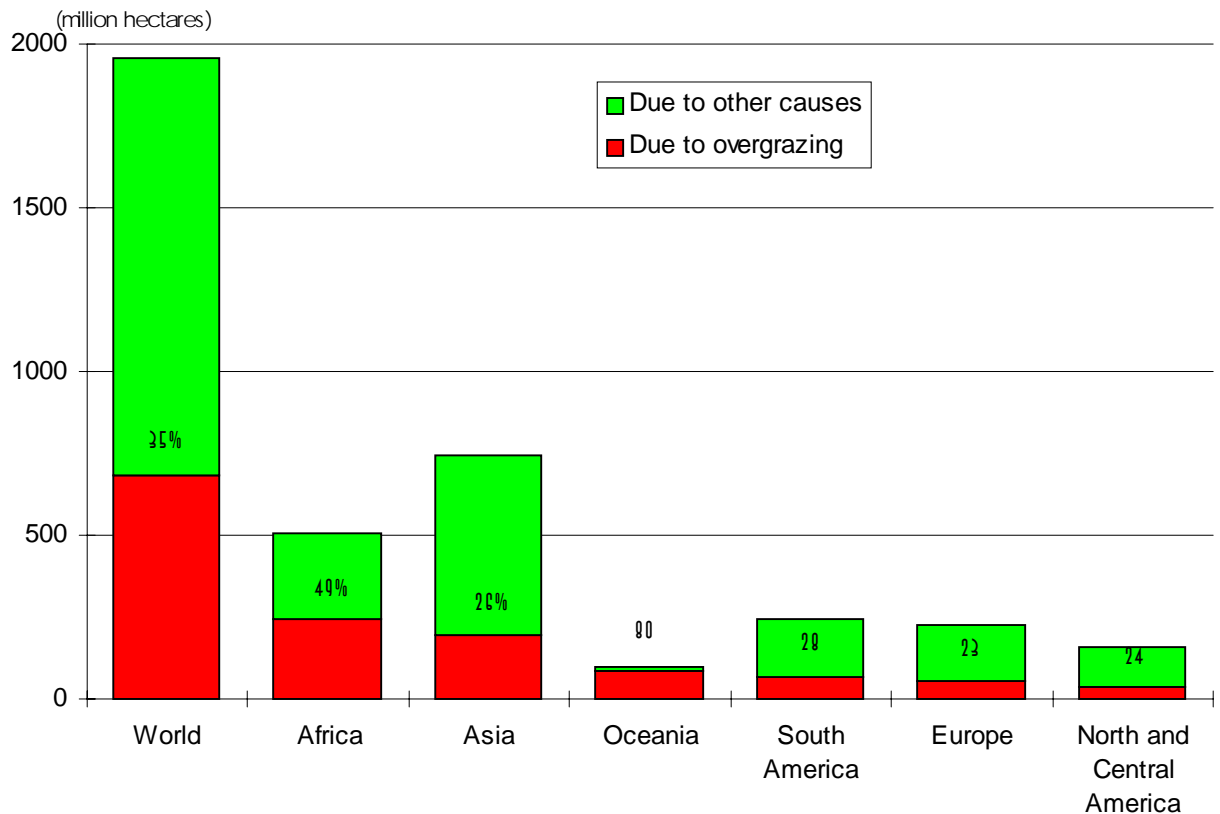
NOTE: Permanent Pasture: Lands used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing lands) - FAO, 1993. Rangelands in arid/semi-arid areas include permanent pastures and land not suited for other uses. Livestock: Cattle, goats, sheep and camels.

Figure 2. *Trends in human/livestock population and permanent pasture in 36 arid/semi-arid developing countries*

Source: FAO, 1996

Land Degradation and Erosion in the Arid/Semi-arid Areas

Because livestock is the major user of primary production in the semi-arid and arid regions, degradation has always been attributed to this sub-sector (Sidahmed and Yazman, 1994). UNEP singled out human impact and, specifically, livestock grazing as being the cause of the irreversible degradation which prevailed during the past two decades (New Scientist, 1992). According to the World Resource Institute (WRI, 1992) "*overgrazing is the most pervasive cause of soil degradation ...In Africa and Australia, overgrazing causes 49 and 80 percent, respectively, of soil degradation, mainly in semi-arid and arid regions.*" Although the share of responsibility on the part of other influences (introduction of exotic species, fuelwood harvesting, suppression of the natural fire cycle, wildlife degradation and conversion of rangelands to croplands or human settlements, etc.) was emphasized in subsequent UNEP publications (WRI, 1994), overgrazing was always considered to be the most important factor (Figure 3).



NOTE: Percentages indicate contribution of overgrazing to total degraded area.

Figure 3 *Rangeland degradation since 1945*

Source: World Resources: 1994 - 95

However, recent results from ILCA's long-term monitoring studies in East and West Africa (Ellis, 1992; Hiernaux, 1993) have challenged this assumption and provided evidence that climate, and not livestock, is the main determinant of changes in the arid/semiarid environments and that the rangelands are resilient and capable of recovery. For example, plant biomass in the Turkana region was greatly influenced by rainfall fluctuations (Figure 1), and has progressively recovered following the lengthy drought of 1979-80. ILCA studies concluded that *"the strong seasonality of rangeland production in the Sahel limits the risk of overgrazing damaging the environment to short periods and consequently confined areas."* Moreover, related studies in Mauritania concluded that the Sahelian vegetation appears very resilient to natural and grazing stresses because of the strong dynamism of the seed production, dispersion and germination cycle (Carriere, 1989).

The results and impact of studies carried out by ILCA and others were discussed in two consecutive workshops supported by the World Bank, the Commonwealth Secretariat, the Overseas Development Institute and others (Behnke and Scoones, 1992; Scoones, 1995) and confirmed the conventional wisdom and traditional practices of the pastorals and nomads throughout the history in these areas. Traditionally, the pastorals adopted an opportunistic strategy of mobility and raised mixed species of stock with different preference to standing vegetation, so as to optimize the use of the limited vegetation available (Sidahmed, 1993). The core of the recent interpretations leading to the so-called *"rethinking range ecology"* is appropriately based on the fact that degradation (or what was considered *desertification*) is mainly influenced by rainfall patterns.

But management of the growing vegetation is equally important. According to Behnke (1993), the resilience of dryland vegetation is an outcome of the marked fluctuations between wet and dry seasons. Whereas growing vegetation is vulnerable to damage by grazing and trampling, dry-season vegetation is far below demand and has its own defensive mechanisms such as protecting the living parts behind thorns or in the seeds. This was confirmed in more than 10 years of range monitoring by ILCA in Mali. The results (Hiernaux, 1993) indicated the negative influence of repeated grazing during the growing season on the replenishment of the soil seed bank. On the other hand, minor changes were found to be caused by the short-term effects of trampling, grazing and burning during the dry season. The studies identified close similarities between the changes induced by drought and those resulting from grazing pressure on the Sahelian rangelands, emphasizing the fact that it is rather the policies (limiting livestock mobility and leading to seasonal dependence by providing feed inputs) that lead to degradation.

The conclusion reached by ILCA's long-term monitoring studies support the recent findings of other investigators in Sweden (Lund University, the Swedish Agency for Research Cooperation with Developing Countries), UK (University College London), USA (Florida State University) and the World Bank (Nelson, 1988). The findings challenge the long-term claim by UNEP that grazing areas of the arid/semi-arid regions, particularly those in the Saharan desert margins (New Scientist, 1992), are subject to irreversible degradation. These reviews and others raised concerns as to the quality and relevance of the research conducted by UNEP on desertification in the Sahel. These concerns related to the absence of evidence of good data or reliable scientific standards.

For example, the satellite pictures examined by Ulf Hellden from Lund University in Sweden, as well as polar-orbiting meteorological satellites analyzed by Tucker and Colleagues from the Laboratory for Terrestrial Physics of NASA, indicated that the desert in the Sahara moves back and forth between its Northern and Southern boundary. According to the studies, these oscillations or north-south/south-north shifts are rainfall-related. Furthermore, Nelson (1988) reported an astonishing recovery by what were considered to be irreversibly degraded areas in Ethiopia, after rainfall following the successive droughts of the 1980s.

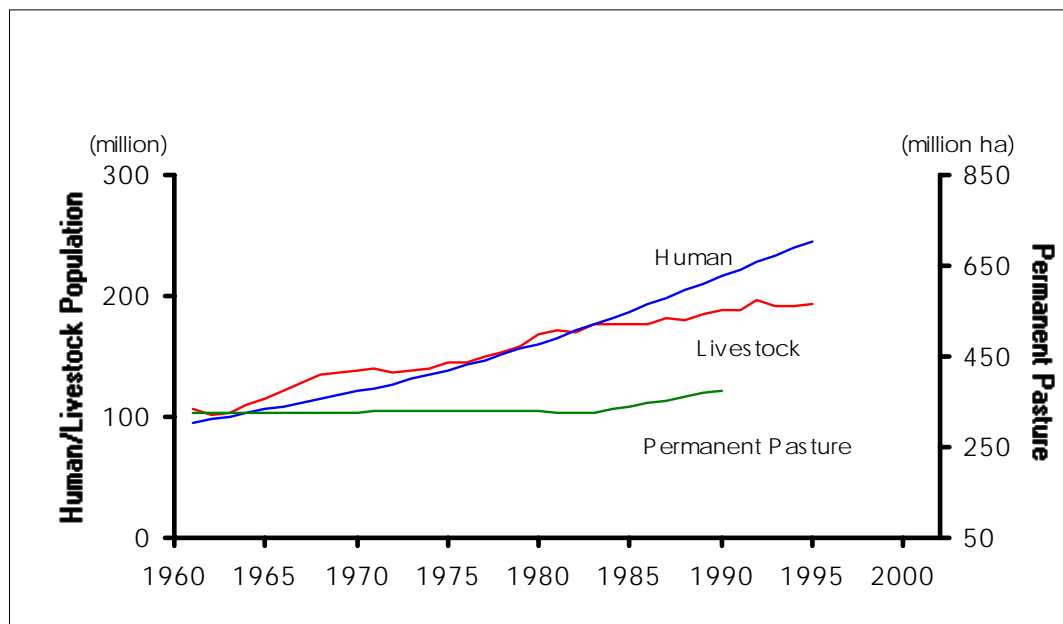
Several ecologists attributed degradation around the water points to livestock concentration. However, this is a one-sided judgment because it excludes the benefits of the manure deposited in the circle just around the water point, as the animals come and go. Andrew Warren, a geographer from University College London, and Hellden, from the University of Lund, Sweden, did not find any evidence of desertification around water points in Sudan. A review of the surroundings of 77 water points in central Sudan and 20 on the desert fringe of Senegal was unable to establish a relationship between degradation and animal concentration around the wells. This and other examples by Warren, brought to the attention of the UN in 1991. According to Warren "*even the view that cattle watering points act as centers or poles of desertification is now questioned*".

Resilience is not only a feature in the grazing lands of arid/semiarid tropics, but also of the continental and temperate dryland areas. For example, an IFAD environmental assessment mission (November 1992) to the Hainan Tibetan region of Qinghai Province could not find an evidence to allow any firm conclusions regarding the claim that overgrazing is the cause of degradation of the robust and resilient summer and winter grazing areas. According to the mission, the species diversity has been kept intact and regeneration would be possible, in spite of the increasing yak and sheep populations. Just as in the case of long droughts in the tropics, periodic very cold winters cause heavy losses in the animal population, leading to reduced grazing pressure and regeneration of the vegetative cover.

The Situation in the Near East and North Africa (NENA) Region

Most of the land area in the region (62%) is classified as rangelands (FAO, 1991), and half of these rangelands are desert and semi-desert, with a limited contribution to controlled or reliable livestock production. The region has witnessed rapid socio-economic change in the last three decades. The areas most affected by these changes are those rangelands which have been encroached by cultivation (Sidahmed, 1991). However, neither the reduction in the rural labor force as a result of out migration to the urban areas, nor the drought years of the seventies

and eighties have brought about a reduction in the number of animals in the region, as might be expected. On the contrary, both the livestock and human population increased sharply in the region between 1961 and 1995; from 105 to 192 million and from 96 to 245 million, respectively (figure 4). On the other hand, the increase in land used for permanent pasture was very small and was limited to Sudan, Saudi Arabia and Libya. Furthermore, human population numbers are expected to double between now and the year 2020 (Sidahmed, 1991), and a similar trend is expected for livestock.



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 arid/semiarid areas include permanent pastures and land not suited for other uses. Livestock: Cattle, goats, sheep and camels.

Figure 4. Trends in human/livestock population and permanent pastures in 19 arid/semiarid Arabic speaking countries

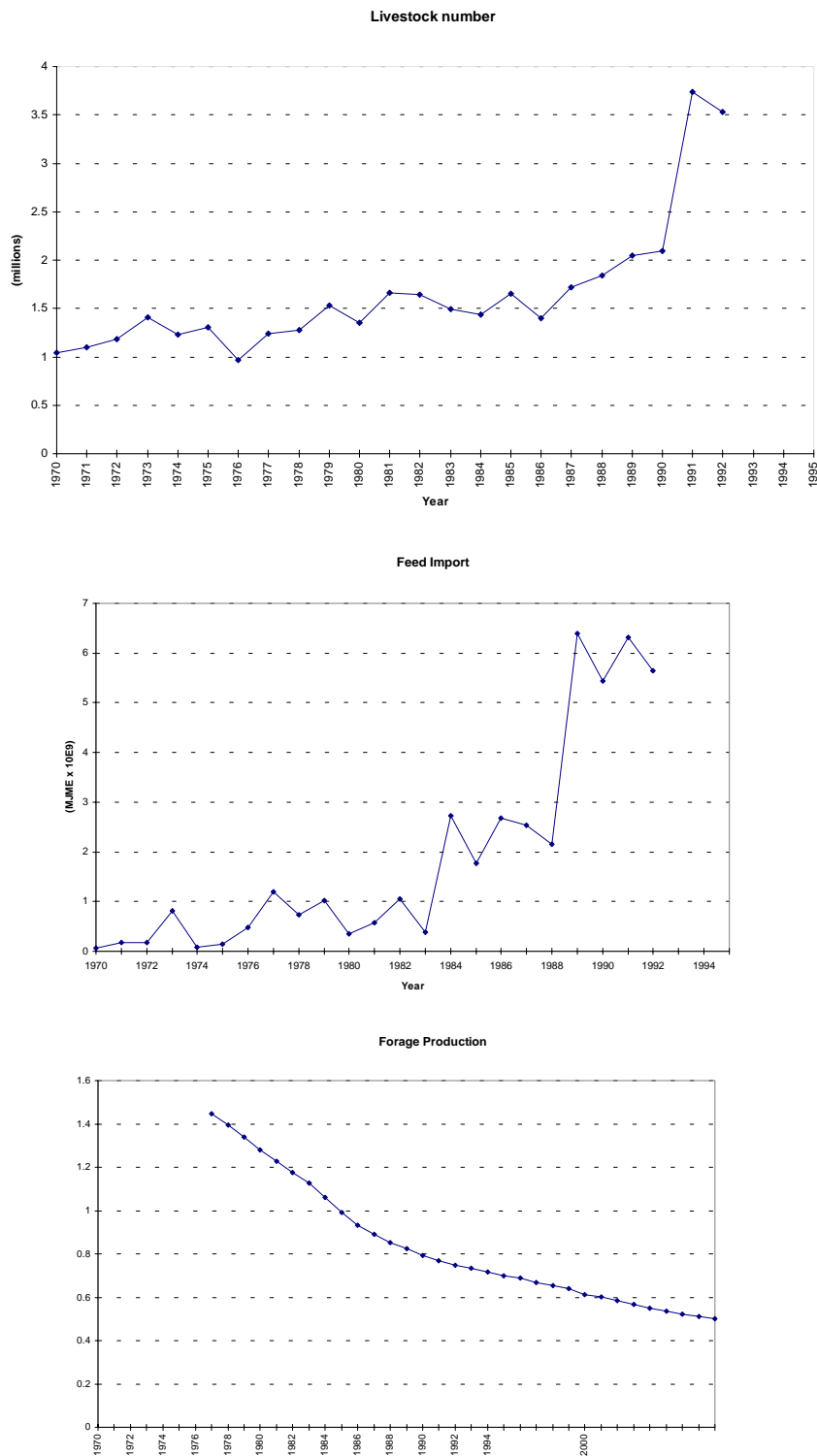
Source: FAO, 1996

In contrast to the majority of the drylands of Africa, extensive livestock production in the NENA region has shifted to systems which are heavily dependent on imported and subsidized feed grain (Sidahmed, 1992). The subsidies mostly favor large herders and absentee livestock owners in the high and middle income countries such as Saudi Arabia, where only 20% of the basic feed resources are provided by range forages and the balance by barley grain. However, supplemental feeding is also very attractive to poor farmers who find financial incentives from converting food grain into animal protein. This is particularly the case in countries where animal value is stable and highly rewarding, compared with local currencies. For example, the price ratio of sheep to grain in Algeria exceeded 20:1 (Bayer and Waters-Bayer, 1995). In semi-arid, central Tunisia, smallholders buy 40% of the feed required in normal years and up to 70% in the dry years. However, availability of supplemental feed does not take animals off the rangelands. Because the natural feed resources are cheap, and since grazing is known to improve meat quality, animals are kept continuously on the range, which disturbs the natural balance and intensifies the degradation process.

There is still much work to be done to assess the effect of these changes on the sustainability of the rangelands and their value for future generations. Limited observations by IFAD missions to Jordan indicated that consumption of green feed doubled between the 1960s and '90s, leading to extensive depletion of the seed supply (IFAD, 1993). In that country, the range supplied 85% of the livestock feed in the 1950-60s, but total consumption

was much lower than the 50% “proper utilization factor.” Although range contribution to animal feed in Jordan has been reduced to only 40% in the 1990s, a sharp increase in animal numbers following a sharp increase in imported and subsidized feed grain (Figure 5), has led to the consumption of very large proportions of the standing vegetation (75-90%). According to this study, the area of rangelands subject to intense livestock grazing has been increased to the maximum limit by the establishment of wells and trucking of water.

Furthermore, based on the modeling exercise used by Peter Harris of the IFAD mission in interpreting the available data, the overall forage energy utilization level increased from 35% in the 1960s to 67% at present. In simplified terms, this means that at least 290 kg of forage needed to be grown in the 1960s (when there was a more lenient, more sustainable utilization level and high carryover) in exchange for 100 kg consumed to keep the rangeland in good shape, whereas under the present regime (overgrazed ranges with little carry-over), only 150 kg is grown for every 100 kg consumed. This might explain the cause of 50% decline in range productivity in Jordan over the last 30 years. Unfortunately, this kind of information is rare and, when available, is based on distorted or uncertain data.



NOTE: Livestock number is a total of sheep, goat, cattle, equine and camel numbers. Feed import is expressed in terms of metabolizable energy. Forage Production is mainly from range but includes crop residues and local bran and grain.

Figure 5. Trends in livestock number, livestock feed import and forage production in Jordan

Source: IFAD 1993

Discussion

A look into the future

There is much argument in favor of optimism with regard to the future of the rangelands in the arid/semi-arid areas. Optimism emerges from the lessons learned from unsuccessful endeavors during the last three or four decades. First, although the failed efforts have discouraged donors and governments from investing in livestock projects, they highlighted the importance of assessing the most suitable approach for the development of the dryland areas. Second, this new direction emerged at a time when it is commonly being accepted that the rangelands of the dryland areas are typically resilient and capable of regeneration, and that the process of regeneration could be delayed by natural forces (one-year and multi-year droughts), or by the interference of mankind.

Furthermore, there is wide acceptance of the negative influence on the regenerative capacity (or speed) of the rangelands caused by indiscriminate settlement policies, distortion of the traditional common property and land tenure systems and policies which influence the year-round presence of livestock in the rangelands through the provision of supplemental feeds and drinking water. Finally, many have now accepted the major role to be played by the traditional herders and pastoral communities in the process of analyzing and solving the constraints to the sustainable use of these highly vulnerable resources.

Considering the belated consensus reached by the international community (**Box 1**), the issue now is how to establish the right processes⁴ to bring about a constructive change towards an era of sustainable management and optimal use of the rangelands in the arid/semi-arid areas. The drylands have a limited but significantly important potential. Measures which add to the conflict or stretch the capacity of the drylands, such as humanitarian efforts to support the livelihood of the increasing human population should be replaced by innovative and sustainable alternatives. Out-migration (to the high potential areas) should be encouraged, but not at the expense of the basic human rights of the immigrants or the inhabitants of the hosts in the wetter humid/subhumid areas. Modern technologies should be used in monitoring and managing the rangelands, but should reflect the needs of the producers in the dryland areas.

⁴ For example, IFAD, which participated in the UNCED process, is actively involved during the interim period between signing the treaty and implementation of the Convention to Combat Desertification (CCD). IFAD is presently assisting selected African countries in preparing their National Action Programs (NAPs), and has indicated its willingness to host the Global Mechanism of the CCD. The Fund is also convening an international forum on local area development to support the implementation of NAPs, in June 1996. The Convention would enter into force once 50 countries have ratified the treaty.

Box 1: United Nations Convention to Combat Desertification

The *Internet* (Interim Secretariat. Geneva: *Secretariat.incd@unep.ch*) carries a leaflet issued by the United Nations Convention to Combat Desertification (Agenda 21: Rio Declaration, 1992: section 2:12). The leaflet summarizes the problem of degradation and offers proposals for a few innovative solutions. First, an end was put to the long debate about desertification and to the concept of irreversible dryland degradation (The New Scientist, 1992; Bontifigliolo, 1992 -UNICEF/UNSO - NOPA). The publication confirms that “*desertification does not refer to the expansion of existing deserts*”, and reaffirms the widely accepted fact that desertification - a misleading term - is, in fact, the degradation of land (mostly rangelands) in the arid, semiarid and dry subhumid areas. The statement attributes equal share of the blame to climatic variation and to human activities

The second important contribution of the leaflet is the call to adopt innovative solutions through local programs supported by the international community. Under this more than 100 governments mostly from the affected countries have signed a treaty. The treaty acknowledges difficulty and length of the struggle needed to protect the drylands, and realizes the complexity of the causes of degradation which include a mix of biological, physical, economical, sociological, political, property rights and trade factors. The countries party to the Convention will implement the Convention by promoting national, regional and subregional programmes. Policies will have to change, and legislation will need to be drawn and implemented. The governments, specially those affected, will remain responsible for creating the enabling environment by making politically sensitive changes such as decentralized authorities, improved land-tenure systems and empowering the users of the natural resources in these fragile areas; the pastoralists, and the rural women and men. Also it was emphasized that the action programs must be fully integrated with other national policies for sustainable development and must be flexible and modifiable when need arises.

Recommendations

Specific actions to ensure the sustainable and realistic use of the rangelands in the dryland areas should be considered from the following interrelated framework conditions (Sidahmed, 1995a, 1995b): policy, socio-economics; institutional, ecological and natural resource management and conservation; and technical framework.

Policy, Socio-economic and Institutional Framework Conditions

Understanding the circumstances of the people who are the traditional users of the rangelands is crucial if any meaningful improvement and development of the unpredictably fluctuating resources of the dryland areas is to be achieved. Governments, regional organizations, regional federations (e.g., GCC) and development agencies need to cooperate in assessing the role of policies affecting the use, protection and improvement of the rangelands, such as:

- the effect of the policies on economic incentives (e.g., farm gate price incentives) for sustainable use of the rangelands. Herders would most likely implement pasture improvement and management interventions when there are sufficient financial incentives for doing such labour-demanding activities;
- the property right policies and the role and effectiveness of the local institutions in regulating the use of rangelands; and
- trends in pastoral economy as affected by settlement and importation of subsidized inputs (this is specifically important in the NENA region).

In addition, legislation should be drawn up to identify the roles and responsibilities of the absentee livestock owners in supporting efforts for proper management of the range resources. The social framework cannot be

effective without strong community support. The viability and out-reach of the formal institutions (such as credit, animal health services) is important in the dryland areas. However, the community organizations (e.g., herders, water point management, marketing, grazing management associations) are very important and should be an integral part of the process of change. Also, the activities of these institutions should be built on the indigenous and traditional practices which have maintained the rangeland production down the centuries.

Ecological, Natural Resource Management (NRM) and Conservation Framework Conditions

The widely-accepted move from the range management concept, based on the *climax* or the *succession* model (Clements, 1919), to the NRM concept (Schacht, 1993; Heady and Child, 1994; Box, 1995) should be exploited to sustain the rangelands for the future generations. NRM is holistic in approach (Savory, 1988), taking into consideration the spatial, temporal and cultural features of the rangelands and the pastoral communities and, if based on reliable information, can offer the basis for future projections. To date, the absence of reliable data is a major problem which has acted as a constraint to our knowledge of the dynamics of the rangelands.

The best survey methods available should be used in monitoring dryland productivity and resilience (Bie, 1990). However, availability of modern technological tools such as the imagery satellite, geographic information systems (*GIS*) and modeling of the grazing systems have not influenced the present management strategies because of the absence of accurate data and ground truthing capabilities. Although it is possible to monitor change in vegetation, there are no appropriate imagery satellite resolutions available for monitoring changes in livestock and pastoral dynamics (Sidahmed, 1994). Other modifications, such as the high resolution airborne systems, the *Multispectral Videography* (Tueller, personal communication) and *low level aerial surveys* (RIM, 1992) are site-specific and require special arrangements and probably additional financial resources. However, these technologies should offer viable approaches for accurate measurements and long-term monitoring of vegetation and livestock dynamics and trends, if the measurements are based on user demand and participation. For instance, if a community understands the benefits of vegetation monitoring, it could avail itself of realistic stock measurements and, by doing so, influence the accuracy of the interpretation of the results. In addition, the recent progress in computer and e-mail technology (*Internet*) should offer NRM a very strong communication and interpretation tool, and should facilitate the exchange of information required for national and regional movements of livestock.

Development and Transfer of Technologies

Past attempts to introduce unrealistic technical packages developed in the stable environments of the high potential areas were unsuccessful. Even the research programs conducted in the dryland range sites did not offer applicable results and most of the findings have remained 'on the shelves' and unutilized. The complexity of the rangeland improvement technologies, lack of full comprehension of the socio-economic factors, ecological unsuitability, lack of incentives to undertake time-consuming and expensive conservation and management activities in publicly-utilized areas are but a few of the many reasons for poor adoption by livestock owners. In addition, research and technology transfer programs were not based on the traditional and the contemporary practices of the locals. Therefore, future attempts for technology development and transfer should be demand-based and should concentrate on applied/adaptive research supervised and implemented by the stock owners themselves.

The traditional wisdom and knowledge of the nomads and the extensive livestock herders is becoming the center of attention. Therefore, future research and technology transfer should be based on well-identified demand by the herders and should build on what was known from the past. New technologies should complement, support or modify useful indigenous skills and practices.

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ANNEX 1

Thirty-six Drylands Developing Countries

Countries are selected based on the paper Sustainable Rangeland in the Near East and North Africa (Sidahmed, 1992; in Rangeland) in addition to Eritrea, Kenya and Zimbabwe. These countries are selected on the basis that most of the country's land belongs to the arid/semi-arid areas as defined as 100-600 mm annual rainfall.

Afghanistan	Israel	Pakistan
Algeria*	Jordan*	Qatar*
Bahrain*	Kenya	Saudi Arabia*
Botswana	Kuwait*	Senegal
Chad	Lebanon*	Somalia
Chile	Libyan Arab Jamahiriya*	Sudan*
Djibouti	Mali	Syrian Arab Republic*
Egypt*	Mauritania*	Tunisia*
Eritrea	Mongolia	United Arab Emirates*
Ethiopia	Morocco*	Western Sahara*
Iran	Niger	Yemen*
Iraq*	Oman*	Zimbabwe

*Arabic speaking countries.