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The Crisis in Dryland Pastoral Economies: An Essay in Applied Human Ecology

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INTRODUCTION

The world's arid and semi-arid zones occupy some 40 million km², or about 35 percent of the total land area.¹⁾ Of this some 8 million km², approximately 8 percent of the total, is hyperarid or "true desert", whereas the renewable natural resources of the remainder can, in principle, be productively used by man. Irrigated agriculture is practised over 2.5 million km², 1.7 million km² is used for rainfed agriculture, and 36 million km² is utilized by pastoralists and ranchers as rangeland.

Together the drylands are inhabited by some 600–700 million people, or about 17 percent of the world's population. Of these approximately 60 percent live in the drylands of Asia and Australia, some 17 percent around the Mediterranean Basin, 12 percent in the arid and semi-arid lands of Africa south of the Sahara and 11 percent in the Americas. The drylands of the Indian sub-continent are the most densely populated. Only 1 percent of the total population of the drylands inhabits the hyperarid regions, whereas 27 percent dwells in the arid zones

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- 1) This article discusses those zones where vegetation suffers from a lack of water for the greater part of the year as a consequence of low rainfall and high evaporation. The term "desert" is reserved for those areas where vegetation is scarce or absent. "Hyperarid" lands are virtually unpopulated areas of extreme aridity where vegetation is limited to ephemerals (short-lived plants that remain as seeds during the dry period and rapidly complete their life-cycles in rainy periods) and shrubs along watercourses. Their index of climatic aridity is < 0.03 (PENMAN method). The "arid zone" comprises areas supporting sparse perennial and annual vegetation, and having a climatic aridity index between 0.03 and 0.20. These areas can sustain pastoral nomadism but not rainfed agriculture. The "semi-arid" bioclimatic zone, which has an aridity value of 0.20 to 0.50, is characterized by steppe or tropical shrubland with a discontinuous herbaceous layer and an increased frequency of perennial plants, and supports both pastoral nomadism and rainfed agriculture. On the moister margins the semi-arid zone merges into the "subhumid" zone, which has aridity values of 0.50–0.75 and is characterized by a denser vegetation, including tropical savannas, mediterranean zone vegetation and moister steppes. Rainfed agriculture, based on plants adapted to seasonal droughts, is the main economic activity of the subhumid lands. The term "drylands" means hyperarid, arid and semi-arid lands as a group. "Desertification" refers to the process whereby desert conditions are increased in either intensity or extent as a consequence of reduced biological productivity resulting in a reduction of plant biomass and an area's capacity to support livestock and crops.

and 72 percent lives in semi-arid areas. Livelihood data are scanty and unreliable, but 63–72 percent of the dryland population is believed to be engaged in agriculture and 6–7 percent is nomadic pastoralists or ranchers.

Estimates of the threat of desertification on particular populations are also extremely tentative, nevertheless it is thought that some 80 million people are directly or indirectly threatened by a decline in the productivity of the arid and semi-arid lands. The livelihoods most directly threatened are those of agriculturalists in Asia (14 million) and the Americas (13 million), townspeople of the same continents (8 million in each area) and the pastoral populations of Africa and Asia (7 and 6 million respectively) [UNCOD 1977a: 14–18].

All arid and semi-arid lands suffer from problems that are essentially ecological in nature. Many irrigated areas are afflicted with salinization, water-logging, alkalinization or sodation; rainfed agriculture is practised in areas best left under perennial vegetation; and, above all, the rangelands of these zones have deteriorated to an alarming degree owing to prolonged and intensive overuse. In addition to sustaining a large human population, the world's drylands, under appropriate management strategies, could make an increased and major contribution to world food supply, particularly in the production of meat. Yet these are fragile environments which, when subject to inappropriate systems of renewable natural resource use, suffer from severe ecological disruption and degradation. Given the vast area and physical, biological and human importance of the arid and semi-arid zones, the potential scale of the human tragedy that could result from their continued mismanagement gives rise to a deep and urgent concern. Indeed, the future of the drylands is of central importance to the well-being of mankind.

ECOLOGICAL CHARACTERISTICS OF DRYLANDS

The basic ecological characteristic of drylands is that plant production is limited by the scarcity or absence of water. Although in some areas plant growth is also limited by soil conditions or low temperatures it is generally true that plants will flourish in arid and semi-arid environments if water is made available. In addition to being adapted to the severe climates of these zones, the wild vegetation is also adapted to erratic rainfall as well as to extremes of precipitation. Wild perennial plants are distributed and regulate their production to maintain a balance with the long-term average of available water. Sudden, episodic rainfall which cannot be responded to by the perennials results in a rapid and short-lived growth of ephemeral plants. Surplus water runs-off via surface channels, enters the aquifers or is rapidly evaporated.

Sustained human use of the tropical and subtropical dry zones has been closely adapted to the low and erratic precipitation through the traditional re-

sponses of pastoral nomadism or rainfed cultivation in the moister areas. Development activities have usually focused on the provision of freshwater via irrigation systems or watering points and on substituting dryland crops and domesticated livestock for the native flora and fauna. The human use of drylands, particularly those of the Old World, is as old as civilization itself, and from all indications degradation of the world's arid and semi-arid zones has been underway for many millennia, although in more recent times its rate has increased alarmingly.

The fundamental cause of the deterioration of the fragile environments of the world's drylands is increasing population pressure, although this has a differential impact in the various areas. This pressure is accentuated by the rising expectations of dryland populations and by the intrusion of the cash economy that everywhere is a concomitant of development. The magnitude of this rapidly increasing population pressure is well illustrated in Rajasthan, where in a 1,989 km² tract the population has increased from 36,000 to 96,000 in just 70 years [CAZRI 1977: 14]. And the fragility of the semi-arid and arid zones has nowhere been more starkly illustrated than in the Sahelian drought of the late 1960's and early 1970's which represented a human tragedy of gigantic proportions and on a continental scale. Although far from precisely established, the estimated rate of desertification highlights the rapidity with which the environments of the world's tropical and sub-tropical dry zones are deteriorating, and dramatizes the speed with which remedial measures must be designed and implemented. In the Sudan, the southern limit of the Sahara has moved some 100 km southwards over the past 17 years, at the rate of about 6 km a year; and it is estimated that worldwide desertification is proceeding at an annual rate of 60,000 km²—twice the area of Belgium. It is further estimated that a total of 125,000 ha of irrigated land, 3.2 million ha of rangeland and 2.5 million ha of rainfed cropland is being degraded per annum. Vast areas are threatened by desertification. It is calculated that worldwide 3.4 million km² (6 times the area of France) is under very high risk of desertification; that 16.5 million km² is subject to high risk; and that a further 17.7 million km² is under moderate risk.

Factors Causing Change in Drylands

Despite large fluctuations in the size and distribution of the world's drylands through geological time and more recently, the present processes of desertification are not attributable to general climatic change (although locally this may be a factor for a variety of reasons) but are caused by man's misuse of renewable natural resources. The most important causes of change are: the extension of irrigated farming into unsuitable areas; the use of inappropriate irrigation technologies and mismanagement of irrigated land; the extension of rainfed agriculture into unsuitable areas; overgrazing (combined with drought) and deterioration of rangelands; collection of fuelwood; and the reduction of wild fauna, particularly herbivores. This article examines some of the problems of renewable natural

resource use and management in the world's arid and semi-arid zones illustrated by special reference to pastoral economies and grazing land management.

PASTORAL ECONOMIES AND GRAZING LAND MANAGEMENT

Pastoral nomadic economies, which probably arose as an off-shoot of settled, agricultural communities, have supported major civilizations and important military, political and social forces for many millenia within and on the borderlands of many of the world's arid and semi-arid zones. Problems of census accuracy and definition preclude a precise enumeration of the number of pastoralists in the world today. The pastoral population of West and North Africa is conservatively estimated at some 10–15 million and that of East Africa as approximately 6–7 million [WIDSTRAND 1975: 148]. It is estimated that at present the arid and semi-arid zones together support over half the world's stock of cattle, more than 30 percent of its sheep and some 60–70 percent of its goats. But livestock productivity in non-industrialized countries of these zones is only some 10–20 percent of that obtained in modern animal husbandry [UNESCO 1977: 13]. In the North African and Near and Middle Eastern region alone, approximately 94 percent of the land area is rangeland which receives an annual average precipitation of 400 mm or less, and some 55 percent of the area of West, East and Southern Africa comprises rangeland with an average rainfall of less than 600 mm per year. Yet these lands support nearly 500 million head of livestock that yield about 2.5 million tons of meat valued at U. S. \$2,500 million (1975 prices) per annum, in addition to substantial quantities of milk, wool, hides and draft power [F. A. O. 1975: 1]. Most of the livestock supported by the drylands of the non-industrialized nations are raised under some form of nomadic economy. Most also utilize rangelands or natural pastures, which contribute a high percentage of national forage production; 90 in Iraq and Sudan, 86 in Jordan, Lebanon and Iran, 70–80 in Pakistan and 50 in Syria [ARAR and HUSS 1977: 6].

Pastoral nomadic societies make a great though generally a vastly underrated contribution to the national economies of those developing nations with large tracts of arid or semi-arid territory. Almost all nomadic animal husbandry takes place in marginal areas too dry to support non-irrigated agriculture, and apart from where such local exceptions as abundant water supplies or exploitable minerals occur, pastoral nomadism offers the only mechanism for the productive and sustained use of renewable natural resources. Grazing of livestock may provide a means of achieving maximum systems stability in regions where long-term sustainability of more intensively managed systems has either not been demonstrated or has been shown to be impossible. Were it not for the pastoral nomad it is probable that most of the arid and semi-arid lands of the Old World would be largely devoid of human inhabitants.

But in spite of their economic and ecological importance and despite severe environmental degradation and the acute poverty of their inhabitants, the rangelands of the dry zones of the developing nations have received relatively little scientific attention prior to the international recognition of the seriousness of the Sahel disaster, and a thorough understanding of the physical, biological and human problems of the arid and semi-arid zones is lacking.

Much of the scientific interest in pastoralism in the arid and semi-arid lands has focused on the relationship between grazing animals and their physical and biological environment, whereas comparatively little attention has been given to the many and complex relationships between human society and the herds. Indeed, the scientific understanding of the man-grazing animal relationship is probably so seriously deficient that it limits the usefulness of the knowledge obtained on the animal-biophysical environment relationship [UNESCO 1977: 8]. This deficiency commonly results in the pastoralist's view of his animals and their environment conflicting severely with the scientist's and administrator's perspective on the relationship between animals and their environment; an incompatibility of viewpoints that has dire consequences for the management of grazing lands in the drylands.

Few if any of the nations of the developing world are equipped to undertake the management tasks of their dry zones, and most do not have a nucleus of technically competent grazing land managers. Knowledge about grazing resources is limited, research in the field is deficient, investment in rangeland development is low, and a lack of institutional and administrative capabilities for rangeland development and management inhibits program development and project implementation. As a consequence, over most of the world dry rangelands have deteriorated to an alarming degree. This is a principal contributory factor to the process of desertification [UNESCO 1977].

In many of the arid and semi-arid zones of the developing world, and particularly in Africa, animal husbandry is an important and integral part of subsistence economies, even when not combined with a pastoral or nomadic way of life. This makes both the definition of "pastoralist" and "pastoral nomadism" difficult. Also there are both sedentary pastoralists and semi-nomadic cultivators; and in some societies there are both pastoralists and cultivators, the former travelling with the migrating herds and the latter remaining at a permanent settlement to take care of the crops, for the mutual benefit of the whole community. Although the situation is both complex and varied, three main types of overlapping categories can be recognized [OWEN 1978: 40-41]: (i) "pure pastoralists", totally nomadic groups which do not practise cultivation and which may be either specialists within a wider economy or only marginally involved in a wider economy; (ii) semi-nomadic groups who perceive themselves to be primarily pastoral but, because they cannot subsist on livestock alone, maintain permanent, agricultural villages in addition to cattle camps; and (iii) "partial nomads",

people who are mainly agriculturalists but also maintain, at least in their own conception, strong pastoral values. The amount of precipitation plays a major role in determining the principal type of nomadism operating in a given area. The number of pastoral nomadic groups, such as the Tuareg of West Africa, who depend exclusively on livestock and who wander each year over a vast territory in search of water and grazing, is diminishing, and most present day traditional pastoralists are transhumant semi-nomads who usually move during the dry season from a base camp to a source of water and food for livestock. Many groups nowadays also are involved in agriculture or trading, as economic complements to their pastoral activities.

Traditional Pastoralism as a Rational Use of Marginal Resources

Pastoral nomadism is one rational form of adaptation to the ecologically fragile arid and semi-arid environment that is characterized by a seasonal rainfall sporadic in both time and space, and a dry season of varying length and severity combined with intense evaporation. Water resources, and then the availability of grazing, are both uncertain and intermittent. Pastoralists inhabiting such zones have responded to the uneven spatial distribution of water and feed by migration. Large tracts of grazing can be used only during the short rainy season, when there is an abundance of temporary waterpools on the soil surface, but for most of the year the herds must be taken to moister areas, in either different areas or at higher elevations, or must be concentrated in the valleys of allogenic water-courses or other areas where water and pasture are readily available. Complicated variations in the temporal and areal distribution and the quality and quantity of water and grazing resources give rise to the complex variety of pastoral systems and nomadic movements.

Pastoral migrations are an integral part of nomadic adaptation, and represent a flexible adjustment to a varied environment. The cyclical migrations are closely adjusted to the shifts in the Intertropical Convergence Zone, and, although therefore seasonably regular, tend to assume broad directional pulsations rather than a specific route, as, for example, among the Somali pastoralists [JOHNSON 1975: 77].²⁾

The sophistication of the pastoral nomadic adaptation to the marginal and extremely varied environment of the tropical and sub-tropical dry zones is also reflected in the mixture of animal species herded. Close assessment of and intimate familiarity with local conditions also determines the timing of movement, the stocking ratio and the composition of the herds. Careful analysis by the pastoralist of how best to achieve his goals by manipulating locally available resources results in the selection of the basic subsistence animals and the com-

2) Although such broad-scale tribal movements among pastoral nomads are well understood, there is little systematic information on small-scale movements among the ecological systems of the major ecological zones.

plementary species. The animals herded have distinct requirements and the selection of several species enables the pastoral inhabitant of marginal environments to exploit ecological niches that would otherwise remain underutilized or even unused. In this way, the nomadic economy is also insured against natural hazard, an ever-present threat to the less drought-resistant animals. Risk is minimized by maintaining capital reserves in different animal commodities and in different geographical locations.

Camels and goats are the domestic stock best adapted to arid and semi-arid ecosystems. Both consume a wide range of vegetation and utilize many plant species that are totally unacceptable to other livestock. Both animals prefer browse, when available; the goat can climb trees to obtain it, and the camel uses its weight to bring relatively large branches within its reach. Moreover, both can go for long periods without water. The camel is particularly valuable as it can forego water for 10–15 days and exist on dry herbage alone for journeys of 25–30 km. Sheep and cattle, on the other hand, are considerably more critical. Sheep selectively graze grass and forbs, their selectivity varying among ecosystems depending on the different ranges of available plant species. Only when the preferred species have been totally consumed or dried out will sheep eat low browse. Sheep also have critical water requirements. In Australia they require 3.5 litres per day in the dry season and are thus restricted to within 2.5–3.0 km of watering points [GRAETZ 1973; LANGE 1969]; some Old World breeds, however, may be able to browse at twice this distance from watering points [WARREN and MAIZELS 1977: 42]. Cattle, which also prefer herbs and forbs, cannot remove herbage less than 12 mm from the ground, hence in moister seasons they do not compete with sheep which can graze much closer to the soil surface. They also browse more readily than do sheep, and have a higher reach, but in the dry season can require some 20–30 liters of water per day and thus are restricted to grazing within 5–10 km of a watering point [HEADY 1960; Vos 1975: 169].

The movement of livestock over an arid and semi-arid grazing range is determined by the periodic need for water and by the search for starch, sugar, nitrogen, phosphorus and fibre from palatable species of the wild vegetation. Apart from water, the most critical need is for starchy and nitrogenous foods. Leaves of green grass and grass seeds can provide a balanced diet for cattle and sheep. But during the dry season all species of domestic livestock must feed on the pods, seeds and leaves of trees and shrubs, evergreen sources that can tide the stock over until the new grasses are again available [WARREN and MAIZELS 1977: 43].

Many of the socio-economic institutions of pastoral nomadic groups function as complements of the cultural-ecological adaptation of migration and herd diversification in minimizing risk of hardship in times of drought, rather than as mechanisms to maximize possible economic return. Techniques for risk management among nomads largely take the form of stock redistribution systems which include, redistribution systems via ritual leaders, "stock-friends", raiding and

barter [HJORT 1976a: 71–73]. In a traditional society under stable conditions mechanisms for redistributing stock constitute an effective insurance system, but under the uncertainties introduced by modernization schemes and with the increasing rate of ecological deterioration, traditional insurance systems are urgently in need of viable supplements, such as the cattle insurance blocks of Northern Kenya [HJORT 1976b]. The “stock-friend” system is a complex network of reciprocal obligations which take the form of a mutually beneficial arrangement between two adult male kinsmen, relatives or friends whereby at a given time the one who is well off helps the less fortunate with the “loan” of an animal. The “loan” is repaid in kind at some later time when fortunes change. In some societies, such as that of the Boran of Ethiopia, ritual leaders receive gifts of livestock for performing services. These gifts are then redistributed to the needy within the community. The bartering of different livestock species is also commonly used among neighboring societies to rebuild decimated herds. Formerly important, but now apparently reduced, is raiding to steal livestock from neighboring peoples in order to rebuild herds [SWEET 1965].

Storing food is a common means of risk management used by subsistence societies to lessen the impact of seasonal food shortages. Pastoralists usually store food on the hoof, and thus to planners and administrators may appear to maintain unnecessarily large herds that in part aggravate the deteriorating ecological situation. And some misguided social scientists have attributed this strategy of building-up large herds as a hedge against uncertainty as an irrational desire for prestige animals, an interpretation that has only served to further condemn the nomad in the eyes of the modern sector. Some animal products such as dried and preserved meat, ghee and yoghurt are stored for several months by pastoral nomads, and in certain localities it may be possible to store surplus grass for use as dry season fodder.

During periods of adversity many pastoral nomads have traditional fall-back activities such as hunting, gathering and agriculture that can tide them over until the condition of their herds improves. Nowadays many pastoralists also seek temporary employment, sometimes for several years, in urban markets and invest in land during the drought period, later selling their investment to purchase new livestock as ecological conditions improve.

Although condemnation of the pastoral nomad has long been commonplace among central government planners and decision-makers, and as a reaction it has become equally fashionable to rise in defence of the nomadic peoples, objective analysis clearly indicates that pastoral nomadic activities have evolved sophisticated resource systems for the sustained utilization of the marginal resources of fragile dryland environments, and that they make a substantial contribution to both the G. N. P. and the supply of essential foodstuffs in many countries of the developing world. Moreover, when not dangerously intensive, the grazing and simple rangeland management practises of pastoral nomads are known to improve the

productivity of wild pastures [WARREN and MAIZELS 1977: 43–45]. Light grazing increases the vigor and growth of plants and in some species, such as the valuable African grass, *Themeda triandra*, removal of coarse, dead stems permits succulent shoot to sprout. Grazed pastures are richer in nitrogen than those left ungrazed as a consequence of the speeding of the nitrogen cycle via animal droppings [LEIGH 1974], and seeds of some valuable species ingested by livestock are deposited, enveloped in fertilizing dung, in new locations. Rapid, low-temperature burning as a grassland management tool is also important in speeding the growth of new forage, removing the residue of old growth, stunting the growth and thus the competition for scarce water of the less palatable plants, and speeding the nutrient cycle. Both light grazing and burning can increase species diversity by opening-out the community and creating more niches [WALKER 1974]. Not only do these practises increase rangeland productivity, but may also increase its resilience by creating niches for new species and by inhibiting the rate of erosion under grass. However, such practises are clearly deleterious if perennials are destroyed or damaged to such an extent that they can no longer function as drought refuges in years when annuals fail to germinate [WARREN and MAIZELS 1977].

Traditional Pastoral Economies in Crisis

The pastoral nomad has traditionally responded to spatial and temporal variations in the ecosystems of the arid and semi-arid zones by geographical mobility combined with adjustments in the density of human and animal populations and the composition of the herds, to make them compatible with the carrying capacity of various fragile environments. In this way a delicate balance was achieved and sustained between the human population and its domestic animals and the limited carrying capacity of the dryland resources. But everywhere in recent decades these delicate balances achieved or sought by traditional pastoral nomadic economies have been upset; a phenomenon reflected in the alarming deterioration of the rangelands in all of the non-industrialized nations of the world's tropical and sub-tropical dry zones. Almost all traditional nomadic pastoral economies now exist under crisis conditions that are largely man-made. Although the roots of this crisis vary from area to area, invariably it has resulted from a combination of the following factors: the incursion of sedentary farmers into lands hitherto used almost exclusively by pastoralists; conflicts with politicians and central government decision-makers and planners; the introduction of cash economies; and ill-conceived modernization programs directed at pastoral nomads. The first two factors are the key causes of the crisis. The crisis has therefore principally arisen as a consequence of the interplay of factors external to the pastoral nomad and almost completely beyond his control.

Historically, the economies of pastoral nomads and sedentary cultivators have been complementary in function and in the use of geographic space and renewable natural resources. Now, however, crop production and animal hus-

bandry have become competitive, especially in the semi-arid areas, a factor which has manifested itself in an over-population of people and animals. This demographic pressure is in part attributable to the rapid rates of population growth characteristic of most developing countries, and although rates of increase among pastoral nomadic societies are lower than among sedentary cultivators, the arid and semi-arid zones have throughout history produced a surplus population that tended to over-exploit. Hence there has been a long-standing tendency toward both over-exploitation of the renewable natural resource base and out-migration.

Competition which has often resulted in violent clashes between the nomadic pastoralist and the sedentary cultivator has arisen as a consequence of the unprecedented growth in the sedentary population which has actively sought to extend the area under cultivation to produce subsistence and cash crops. In some semi-arid areas the ranks of the traditional cultivators have been swollen by recently settled communities who were formerly integrated into the pastoral nomadic economy but who now have taken up sedentary cultivation. During the past 30 years the rangelands have receded under a veritable "land grab" by peasant cultivators, who with increased manpower and greater needs have penetrated the traditional domain of the pastoralists in a broad pioneer frontier extending from the coast of West Africa to Iran. A similar situation exists in the drylands of Latin America. In many areas, and particularly in the Sahelian region, this has extended cultivation into areas unsuitable for agriculture and has pushed the rangeland and the pastoralist into the least hospitable environments.

The Sahel provides the most striking illustration of this process, where, between the two most recent drought periods of 1940-1944 and that starting in 1966, a relatively humid phase of some 20 years encouraged the northward expansion of the agricultural frontiers and general northward drift of the pastoral groups from the semi-arid to the arid zones. Pressure on the pasture land by cultivators has become so intense in Niger, for example, that legislation was introduced in the early 1960's to protect the interests of the pastoralist by limiting clearance for farming. In large part, the withdrawal of the pastoralist into the most arid environments that could not be exploited for agriculture led to the disastrous impact of the recent drought in the Sahel.

In addition to being isolated in the least desirable and most inaccessible regions many pastoral groups have been deprived of dry season pastures and sources of water. Commonly, the nomad was permitted to graze his stock on the stubble in the cultivator's fields during the dry season; one element in the mutually beneficial traditional symbiosis between pastoralist and cultivator. But now in many areas the fields are devoted to a dry season crop, particularly cotton. Similarly, river banks and the moist areas around permanent or semi-permanent water bodies are increasingly devoted to flood-retreat crops or to rice cultivation, depriving the pastoralist of lush pastures and water that were traditionally free of

access. The final blow usually falls when modern agricultural developments, like those in the Awash valley of Ethiopia, suddenly deprive the pastoralist of valuable pastures which had always been their last resort. Other areas are lost to nomads by the creation of game reserves and conservation areas.

Traditional pastoral nomadism in the drylands of the Old World did not acknowledge individual land ownership or water rights. All resource rights were vested in the clan or tribal groups, although small groups such as family units or kin groups often controlled rights to waterholes, and as such they were based on the assumption that land *per se* is not a scarce resource. Land fragmentation, common among farmers, was not traditionally experienced by pastoral nomads, but instead they faced the problem, which has now reached alarming proportions as a consequence of restriction on their seasonal migrations and access to grazing land, of overgrazing accompanying the excessive use of waterholes. As a result the grazing around the source of water is destroyed and the area becomes invaded by bushes usually unpalatable to all livestock except goats and camels. Nowadays, pastoral nomads are faced with a land scarcity, which regardless of its cause, has created ecological imbalances severe enough to have resulted in desertification and extreme hardship for the nomads, leading to out-migration and deteriorating nutritional and health levels for those who remain in the marginal, arid areas.

(i) ECOLOGICAL ROOTS OF THE CRISIS

Whereas light grazing and the associated simple management practises of pastoral nomads practising traditional systems is known to improve rangeland conditions, heavy grazing and its associated management practises leads to degradation, the rate of deterioration depending on the biological productivity of the forage, its palatability, manner of forage use, and the recent sequence of climatic events. The effects of overgrazing on dryland ecosystems are both direct and indirect; the former category includes trampling and grazing by stock, and the latter changes in flora, fauna and hydrology.

Trampling by the hooves of overly large herds concentrated around dry season watering points causes much greater ecological devastation than does over-eating of vegetation. Trampling quickly destroys some species leaving the hardier and less palatable species and rapidly increasing the proportion of bare ground. Under dry conditions, soil, soil humus and organic litter are trampled to dust and removed by the wind; and during the wet season puddling occurs, which reduces infiltration and accelerates run-off, resulting in further soil loss. Moreover, concentration of stock around a few watering points also concentrates their droppings and urine so that they denitrify without being returned to the ecological system, but, on the other hand, possibly leading to the serious nitrate contamination of the local water supply [WARREN and MAIZELS 1977: 45].

Too heavy grazing can severely curtail photosynthesis, leading to the death of grasses and forbs [TUELLER 1973], and browsing and lopping of shrubs and

trees to provide fodder distorts growth forms and leads to death. But the most serious impact of grazing on ecosystems is the inhibition of seeding in grasses and some tree species after drought and heavy grazing [BILLE 1974; GILLET 1975: 27]. Seeds and young plants are so quickly devoured that many plant populations are aging without being able to replace themselves [DEPIERRE *et al.* 1975: 44]. This may be serious for plants that require fire for regeneration: fire being episodic and the plant may not survive long enough to experience the occasional year in which it can regenerate. Severe pauperization or outright destruction of the vegetation over large areas facilitates soil erosion and decreases the chances of rangeland recovery even with the end of a drought or the relief of overgrazing.

Changes in flora, fauna and hydrology take place as a result of overgrazing. When the competition from palatable plants or those prone to damage by trampling is reduced, resistant and unpalatable species usually expand their coverage. The damaged area is also commonly invaded by plants from neighboring, more arid regions. Woody shrubs are also common invaders, which reduce the production of pasture grasses. Changes in wild macro-fauna occur as a consequence of over-grazing, although the dynamics of this phenomenon are not well understood, and other factors such as hunting, disease control or the reduction of predators may also operate. Although data are scant, the impact of grazing on invertebrate fauna may be more significant. Declines of over 60 percent and radical changes in the species composition of Australian arthropod populations have been observed on heavily grazed pastures [HUTCHINSON and KING 1970]. This may result in changes in the pollination and germination of some plant species, and may have a serious effect on bees and honey production, for example [WARREN and MAIZELS 1977: 48]. Heavy grazing and trampling may favor the expansion of desert locust populations, which require bare ground for breeding [HASKELL 1969; Vos 1975], and tsetse flies may increase together with the invasion of woody scrub vegetation [UVAROV 1962].

Severe trampling and heavy grazing, by damaging the soil surface, has a major impact on the water balance of arid and semi-arid lands. The critical change takes place in the infiltration capacity of the soil surface; on sandy soils it is probably increased severalfold, but on the bare surface of more silty or clayey soil hardening and encrustation decreases infiltration. Surface evaporation losses are also increased on bare soils, and in some cases lead to local salinization where deeper-rooted plants have been removed and watertables have risen. In other areas, decreased infiltration appears to have resulted in falling watertables. The absence of evaporating surfaces allows air temperatures to rise and because the soil is both drier and more subject to temperature fluctuations, its biological activity is restricted [MOORE and BDDISCOMBE 1964]. Further, less infiltration, reduced evapotranspiration and smoother soil surfaces lead to increased run-off, which in turn leads to higher rates of soil erosion that reduces both the depth and the water-retaining capacity of the soil. Finally, efforts to increase available

water supply by tapping groundwater lead, in many instances, to a gradual decline in regional water reserves.

Used judiciously, fire is an excellent tool for managing semi-arid rangelands. It effectively removes stifling old growth and allows new grass shoots to grow; speeds the recycling of soil nutrients; discourages scrub and therefore—in addition to destroying such pests and diseases as tsetse and trypanosomiasis—encourages the growth of grasses; and can be used to clear accumulated debris, thus lessening the risk of an accidental and more damaging fire. However, fires that burn too hot or consume too much fuel can remove all soil litter, a large percentage of its humus, as well as sterilizing nitrogen-fixing bacteria; nutrient-laden ashes may be blown or washed away; and increased soil friability can result in accelerated erosion. Burning can also change the composition and concentrations of plant and animal species.

(ii) SOCIAL ROOTS OF THE CRISIS

Many nomadic populations living in the extreme marginal areas that are undergoing desertification are trapped in a vicious web of inadequate diet, disease, poor sanitation, acute lack of health services, and, as a consequence of deteriorating environmental, economic and social circumstances, together with a deterioration of their own physical conditions, are suffering severe demoralization and emotional stress [ROBOFF 1977]. Their poor health status undermines their already tenuous ability to cope with changing circumstances. The causes and consequences of this situation, although multi-faceted and closely interwoven, are not difficult to understand. The loss of resource productivity alters traditional diets; key foods disappear, causing a reduction in calorie, protein and vitamin consumption, and traditional foods may be exorbitantly priced, if available at all. Available inexpensive foodstuffs are often nutritionally poor. Moreover, food is not necessarily perceived as being related to human health. Pastoral groups who rely primarily on their livestock for protein are in extreme jeopardy when milk supplies cease or animals perish owing to a lack of grazing or other food. Traditional famine foods consisting of wild berries, leaves, shoots, roots and small animals have provided a standby during drought periods but as desertification intensifies these also become scarce. But because of greater reliance on cultivated foods, traditional skills for procuring famine foods are now being forgotten, or may never have been learned by children, as exemplified by the Sandawe people of Tanzania [NEWMAN 1975]. Moreover, the process of desertification also widens the environment for many arid zone diseases, such as leishmaniasis and trachoma, that readily infest the nomadic people whose resistance has been undermined by malnutrition.

Conventional wisdom has long indicated that nomadic pastoral populations were inherently healthier than those of sedentary farmers. Protein in-take, for example, can be three to four times greater among nomads than for other rural populations and lower population densities should result in a lower incidence of

contagious diseases [ROBOFF 1977: 423]. But recent clinical examinations challenge these assumptions. Studies from drought-stricken areas of Saudi Arabia and refugee camps in Upper Volta and Mauritania show that children suffer from a higher incidence of acute malnutrition, as well as parasitic and communicable diseases [SEBAI 1969; SEAMON *et al.* 1973]. In Upper Volta, clinical malnutrition occurred in 20 percent of the children of sedentary cultivators but in 40 percent of nomadic children [SEAMON *et al.* 1973: 776], and in Mauritania 16.6 percent of nomadic and 8 percent of sedentary children suffered from acute malnutrition [GREENE 1975: 17]. Among Mauritanian nomadic children 65 percent were clinically defined as suffering from severe calorie deprivation compared with 2 percent of the children of sedentary cultivators who were also in the refugee camps [GREENE 1975].³⁾

The impact of the geographically and ecologically marginal localities into which pastoral nomadic societies have been pushed is reinforced by a reversal of their political and social status and the generally negative attitudes which the nomad elicits from central government authorities. Historically, nomadic pastoralists ruled the deserts and the oases within them, and through the settlement of surplus members of their societies in the semi-arid borderlands of the deserts also often dominated the sedentary farmers, from whom they received tribute. Pastoralism and rainfed cultivation generally co-existed in a mutually beneficial symbiotic state and the intrusion of farmers into the rangelands was firmly controlled by the militarily powerful, central nomadic confederations, as in Iran or Niger [UNESCO 1977: 16]. But during the twentieth century the powerful position of the world's pastoral nomadic societies has declined almost everywhere.

Although lower rates of population increase compared with the sedentary farming communities is partly responsible for this change of fortunes, the main reasons for the social and political demise of the nomad has been the almost universal under-administration and lack of arid zone development, the peripheral nature of the pastoral economy and the increasing marginalisation of nomadic populations, and the deliberate policy of many governments to eradicate pastoral nomadism either by design or through neglect.

Traditional pastoral nomadism represents a rational and sophisticated adaptation to the fragile ecosystems of the arid and semi-arid zones, yet it is an adaptation inimical to the nature, objectives and policy of the modern state, regardless of ideology. In large part these attitudes of the modern politician and bureaucrat, often inherited from ethnocentric colonial administrators, are based on a distortion of anthropological theory regarding pastoral values and attachment to livestock, which were invested with some mystical significance and used to explain

3) However, the data should be interpreted with caution because of the abnormality of the refugee circumstance, and although under normal conditions nomadic populations may be inherently healthier than sedentary groups, in stress situations such as occur during periods of severe drought some nomadic groups may be in a highly vulnerable condition in terms of health.

the obviously "non-economic" behavior (in Western terms) of the pastoralist.⁴⁾ The lifestyle of East African herding societies was so alien to the experience of observers who viewed it from a geographical and cultural distance that they could find no suitable explanation other than reference to mystery-exoticism. To the severe detriment of the pastoralist, these ideas still remain prevalent among the politicians and administrators of the newer modern nations [WIDSTRAND 1975: 147].

During the formative stages of nation-building most governments strive to foster national unity by suppressing or at least ignoring and downplaying regional or ethnic differences. But nomadism and the lifestyle of pastoral peoples, a particularly intractable case, are anathema to the modern administrator because nomads cannot be organized in a manner preferred by bureaucrats and in a way that appears to be "modern". Thus to the central government administrator they are difficult to control, administer, tax and to provide with the often questionable benefits of modernization; they run around naked, resist modern medicines and see little value in state-prescribed systems of education. Moreover, crossing regional and international boundaries at will, nomads are often a politically inconvenient group.

Thus in many nations batteries of legislative and administrative measures have been enacted against the nomadic use of land, by restricting, hindering and controlling the movement of people and livestock. At the same time, many governments try to induce the nomads to settle into sedentary agriculture, stock raising or some other economically productive activity, by the provision of incentives, services and physical amenities; most of which, however, have been diverted to benefit already settled agriculturalists as much as the pastoralist. In some countries even systems of taxation are detrimental to the pastoralists, livestock being subject to a head tax whereas farmland is exempt.

Public authorities almost never take the side of the pastoralist. The government of Syria, for example, has explicitly stated its aim to do away with nomadism and its attendant social organization; and even the governments of Saudi Arabia and Jordan, which had their origins in Bedouin Society, are encouraging the settlement of the pastoral nomad and are facilitating the encroachment of sedentary agriculture on the lands traditionally devoted to pastoral nomadism. A clear exception to these almost universal policies is found in Afghanistan which continues to give support to nomadic life, and in particular to the tribes of the Hindu Kush ranges, whose mobility contributes to the integration of the central mountainous region into national life [UNESCO 1977: 16].⁵⁾

4) In 1936, Herskovits published on the "cattle complex" of East Africa, summarizing a variety of observations of and attempting to present a coherent theory on livestock-dependent societies. His main thesis was that the cattle complex was characterized by such a strong attachment to cattle that it structured the entire life of the people and their value system.

5) This article was written prior to the present political situation of Afghanistan.

The impact of the cash economy has also had severe repercussions on pastoral nomadic societies, and has intensified their already marginal economic position. There can be few economic activities which yield smaller and more chancy profits, in the Western economic sense, than pastoral nomadism. This is a consequence of the isolated geographical locations in which the pastoralists live, often at great distances from the main centers of consumption, of the deficiencies of the marketing system which enable intermediaries to exploit the pastoralist, and the extreme irregularity of supply combined with the producers' lack of organization and the seasonality of their visits to market.

Pastoralists can potentially make a large contribution to the general meat supply of the arid and semi-arid zones, and could also provide some meat for export. Given a "normal" age structure and a 70 percent calving rate, the annual off-take of male and old female cattle could amount to some 8 percent of total herds [DAHL and HJORT 1976]. At this level, off-take neither threatens the reproduction of herds nor undermines local subsistence requirements. Yet the marginal position of the pastoralist and the peripheral nature of their production are fundamental obstacles to the increase in the productivity of pastoral nomadic economies. Long distance transportation of cattle on the hoof severely depresses quality and weight of the animals and makes it difficult to organize an effective sales and processing system. Although markets for meat and milk are largely available, the seasonality of supply means that sometimes these commodities are over-abundant, although more often they are in short supply, with the result that prices fluctuate considerably and producers are distressed [BAKER 1968].

In the Sudano-Sahelian region, the private sector marketing of meat and cattle on the hoof is an especially complex system that brings together cattle from several million producers scattered over millions of square kilometers. The marketing system begins with a large number of small-scale buyers visiting primary markets, or buying directly from the pastoralist or from a traditional middleman. The cattle are then driven on the hoof to regional markets where they are purchased by a small number of large-scale merchants. These merchants, who may be members of ethnic groups specialized in the trade, aggregate the smaller lots and transport them to consumption centers where they are received by middleman who sell the livestock to butchers and who return the proceeds to the regional merchants. This traditional private marketing system, although serving to depress the prices received by the pastoralist, is well-attuned to local conditions. It varies its sources of procurement depending on the season and is adaptable to changing conditions of supply and demand. It operates across international and tribal boundaries and copes successfully with such confusing issues as monetary exchange and a plethora of local official and unofficial taxes and other charges. Moreover, it is entirely self-financed and an important employer of surplus local manpower.

Although governments have intervened to improve marketing and infrastr-

ructural facilities and to up-grade the producer's environment by providing more watering points and veterinary services, government fiscal policies have hampered the development of the livestock sector and, in combination with the numerous market intermediaries, have depressed the prices received by the producer. This is exemplified by the taxation and licencing structure. Because of the difficulties inherent in taxing the livestock producer, taxation of stockraising in the Sudano-Sahelian countries focuses mainly on the meat marketing cycle. Meat and meat products are subjected to as many as 15 different official taxes, levies, duties and fees between purchase of the animal from the farmer and the butcher's shop in the coastal districts. (In addition many unofficial "fees" must also be paid.) These include agent's licenses, livestock marketing taxes, municipal taxes, health inspection fees, fees for certificate of origin, export licenses, import licenses, transit licenses, slaughter-house tax, meat inspection tax, license to sell meat and departmental taxes. Such a proliferation of taxes and the disparity in taxation policies between producing and consuming States has led to a discordant marketing system, with many loopholes, and has handicapped the development of the entire livestock sector. Further, taxes on meat and livestock provide approximately 10 percent of the income of the landlocked countries of the Sudano-Sahelian regions, yet government expenditures for the development of the livestock sector amount to only about 1.5–2.5 percent of the national income, and these are largely administrative expenses. In short, the livestock sector is perceived by the governments of the Sudano-Sahelian region merely as a source of revenue; and services commensurate with the sector's contribution to national income are not provided [UNCOD 1977b: 19–20].

Meat prices vary among the countries of the Sudano-Sahelian region. In general, however, only 57 percent of the selling price is realized by the pastoralist, compared with 13 percent for the merchant (8 percent of which is used to pay interest on capital), and 18 percent for the butcher. Taxes and miscellaneous costs account for 12 percent of the selling price [UNCOD 1977b: 20]. Among the Fulani only 11 percent of the consumer price for beef is received by the herders, whereas 28 percent goes to the middleman [F. A. O. 1972].

The impact of the external cash economy has also led to major socioeconomic changes within nomadic groups. Many members of nomadic pastoral groups obtain cash incomes from other sectors of the national economy during drought periods or other times of hardship. Eventually they convert their saving into livestock and resume the nomadic way of life. This has serious repercussions on the traditional social system; redistribution mechanisms decline and occupational, social and economic stratifications emerge. When people can invest in livestock and in improved annual health care so that animals live longer, and produce more offspring, meat and milk, the ownership of livestock becomes a regular and individualized business. Such persons then form a wealthy, upper economic stratum in their society, and no longer enter their improved livestock

into the traditional redistribution systems, but instead segregate them from the main herds and employ special herders [HJORT 1976a: 75]. Offtake of stock for slaughter becomes the main goal of animal husbandry for this elite group. Others specialize in purchasing poor quality livestock, providing them with good grazing, and then selling them for slaughter [F. A. O. 1974].

Supported by localized projects to develop ground water resources and improved veterinary services, and in the absence of complementary range improvement and management schemes, this re-orientation of the richer members of a nomadic society toward the external economy has led to an unregulated growth in livestock numbers and to a rapid and severe deterioration of the rangelands. But it should also be noted that the uncontrolled growth of livestock populations is not attributable to a few entrepreneurs alone, but also to the traditional “insurance systems” of nomadic populations who tend to acquire and maintain an excessive number of animals during good years to ensure that some would survive to provide a nucleus for re-creating the herds during periods of extreme natural hazard.

Although some schemes to sedentarize and modernize the nomadic economy or to provide economic alternatives to pastoral nomadism have been successful, in large part most development schemes have been poorly conceived and poorly implemented, leading to increased disillusionment and heightened mistrust by both pastoralist and administrator. Many projects to develop or settle nomadic communities do not succeed because planners and administrators have failed to understand the total resource system of the pastoral nomad, particularly in terms of his attitudes and perceptions. Programs are presented as neat and isolated packages; and “water development schemes” or “vaccination projects”, in the absence of integral and complementary programs, are attractive only to central planners. Clearly, the sceptical attitude of many pastoralists toward inept national or regional administrations has saved them from many poorly devised settlement or other types of development project [HJORT 1976a]. When such dubious incentives fail, governments resort to drastic “destocking” systems, further alienating the pastoralist. Central administrations fall back on “cattle complexes”, social organization and value system to explain their failures; and the nomad treats the government as just another ecological factor, an external constraint similar to the unreliable rainfall, with which he must cope by taking the proper precautions [SPENCER 1965]. Yet many nomads in widely differing parts of the world have voluntarily sedentarized, either on a temporary basis or permanently, as among some Libyan Bedouin groups or among the Tuareg in the agricultural oases of the Ahaggar [OWEN 1978: 60].

The majority of programs aimed at developing the nomad emphasize increasing the agricultural component of their economies and greatly reducing the focus on livestock, in order to sedentarize them in permanent villages. Quite apart from the failure to select settlement areas that are well-suited to agriculture, many

such schemes are conceptually weak in that they too readily assume that pastoralists are potential peasants. Even though some groups of pastoralists may engage in rudimentary cultivation as an economic complement to their main pursuit, most herdsmen have little direct experience of tilling the soil, a factor that may partly explain why many former nomads prefer to seek work in the industrial or service sectors of the economy. In this context the experience of Somalia in trying to settle nomads after the recent serious drought is illuminating [SOMALIA 1977: 16]. Nomads in relief camps were given the choice of accepting government assistance to either resettle on farmlands to be developed, to settle in existing marine fishing settlements and enter the fishing industry, or to return to the nomadic way of life. The majority, 51 percent, elected to return to nomadism, 42 percent chose to settle in the agricultural schemes and only about 6 percent decided to become fishermen.

In some settlement schemes designed for pastoral nomads the lack of understanding of ecological and pre-existing social factors is a principal cause of failure. An example is provided by the Babanusa Nomad's Settlement Project of the South Kordofan Province of the Sudan [THIMM 1979: 51-55]. In order to settle nomads on ranches for milk production, 44 potential sites, each of 100 km², were selected in the West Kordofan-Babanusa area. Eight ranch sites were selected for permanent occupancy, but the project failed and has been reduced to a straightforward program to provide services to the ranch area. It failed principally because the ranches were established across the traditional migration routes of pastoralist groups and also enclosed large tracts of cultivated land over which both sedentary and migratory populations had acknowledged rights. These rights were strenuously defended. In addition, the carrying capacity of the range was too low to support the number of proposed livestock, and the off-take of meat and milk would not even cover the costs of the operation [THIMM 1979: 53]. Careless site selection was the prime cause of failure, but the result of this project also highlights the neglect of administrators to consult with local inhabitants. The usual reasons for the failure of a modernization project in a marginal zone of a developing country were also manifested: little communication between project management and field staff, low levels of funding, absence of coordination among different government departments, shortage of qualified staff, rapid staff transfer, and lack of facilities for project staff [THIMM 1979: 55; RONDINELLI and RUDDLE 1977].

When a supposedly comprehensive program fails to achieve designed goals, piecemeal and often drastic projects are initiated. Whether a particular project is seen as beneficial or a threat to livelihood again depends on the perceptions of the parties involved. Destocking programs, that have as an ultimate aim the alteration (generally a reduction) of herd sizes and composition, are commonly perceived as attempts to tamper with family relationships in pastoral societies where herd and family are often mutually defining concepts [WIDSTRAND 1975: 151]. Destocking measures have sometimes taken unnecessarily repressive forms

such as shooting of livestock, or the organization of grazing blocks. In East Africa the latter failed since it conflicted with pastoral groups that had a long history of meticulous management of multiple environments [HJORT 1976b: 212]. Marketing programs have also failed, both as a consequence of infrastructural deficiencies, poor planning and the actions of inept officials.

The Improvement of Animal Husbandry and Grazing Land Management

The modernization of pastoral nomadism to increase its productivity, improve the lives and living of herding societies and to mitigate deleterious ecological consequences, demands difficult technical decisions and a firm and continuous commitment by national policy makers. Above all a decision must be taken to integrate the livestock sector, the principal component of which is pastoral nomadism, within the overall national economy, and to allocate to livestock development a proportion of development financing commensurate with its actual (or potential) contribution to national resources. There is no other form of renewable resource use that with such a relatively low investment can so effectively utilize the fragile ecosystems of the arid and semi-arid lands. Further, programs to improve animal husbandry must be integrated and must concurrently seek to restore the ecological balance and up-grade the management of the rangelands of the dry zones. For although prospecting for and developing groundwater resources has made great strides in the last two decades and despite veterinary activities during the same period, rangeland improvement has hardly progressed. Finally, there should be a balance of programs having short, intermediate, and long-term objectives.

The future potential importance of animal husbandry is clearly illustrated by conditions in Africa where demand projections indicate a severe shortage of meat for local consumption combined with sharply increased prices within the next 5 years, unless the growth rate of animal production shows a substantial increase. For 26 African nations an aggregate deficit of one million tons of meat is forecast by 1985 [CGIAR 1973: 16ff]. As there is clearly no possibility that commercial ranching schemes could satisfy this demand in the brief period remaining—particularly since many such enterprises are export-oriented—and that less marginal areas could be switched to exclusively to cattle production, it is imperative that the pastoralists and their ability to make the marginal zones rapidly and inexpensively productive be enlisted by enlightened administrations to avert a severe meat deficit.

To prevent such a crisis, the pastoralist must be fully integrated into national resource use, development and management planning. For integration to succeed a large role must be played by social and behavioral science information, in addition to that of the biological sciences and economics. Application of the considerable body of knowledge on livestock and range management is generally retarded in the cultural milieu of the non-industrialized world by a lack of information

about human behavior. There is also a dearth of basic and simple information of the state and level of existing resource use (although the difficulty of obtaining reliable statistical data on nomadic societies should not be underestimated), which severely handicaps decision-making and planning. There is a particular need to more precisely determine livestock numbers, structure of herds, variety of animals raised, rearing units, degree of dependence on livestock and economic complements to animal husbandry, the nature and degree of human-livestock-environment linkages, social-economic class formation, perceptions of the biological, physical and socio-cultural environments, natural hazards and development schemes, and responses to and causes of failure of past and on-going development projects aimed at the pastoralist [WIDSTRAND 1975: 152-153]. Despite the existence of large gaps in existing knowledge, policy and program recommendations can be made in several areas [DEMIREN 1974 124-26; UNESCO 1977: 26-27].

The fundamental requirement in developing animal husbandry is the regular provision of ample and nutritive food, hence rangeland should be used rationally and animal numbers limited to prevent overgrazing. The rational use of rangeland implies a change in land management policy to replace the formerly sound organizational structures of pastoral societies that have been weakened or destroyed by social fragmentation and the encroachment of sedentary agriculturalists. Restoration of appropriate organizational structures involves the allocation of land specifically for animal husbandry, where the movement of the flocks could be rationally undertaken. Land for pastoralists must also be allocated to coherent pastoral units capable of managing rangeland. Such an arrangement would also prevent investments like watering points intended primarily for pastoralists being appropriated by other users.

Within the framework of precisely defined pastoral areas measures to improve rangelands can be more readily implemented. This involves reducing livestock numbers and using grazing lands in a rotational system. Specific measures must be taken to restore and up-grade pastures depending on such diverse local conditions as soil characteristics and plant species composition, density, nutritive value and biology.

Additional measures must be undertaken to mitigate the impact of the dry season on food supply, as well as to provide supplementary winter feed. The use of trees to provide animal feed has generally been overlooked. A systematic policy to encourage the planting and use of food trees, particularly leguminous species, which could be an important factor in land management schemes, should be explored. Trees could provide dry season fodder and make use of the land around watering points that is generally abandoned for most of the year owing to a lack of pasture [UNESCO 1977: 26]. Existing shrub and wooded areas already exploited for forage should be better managed via the use of a rest or rotational system [NOVIKOFF 1976: 67]. Stored fodder reserves, such as hay, should also be established where feasible,

One of the more feasible methods for decreasing the effects of the annual dry season and the lack of winter supplementary feed is to integrate livestock and crop production more closely. This would require an increase in the irrigated and rainfed areas devoted to fodder and feedstuff production and could capitalize on the traditional symbiotic relationship between pastoralists and sedentary farming communities. It could also serve as a mechanism for the gradual sedentarization of nomadic groups, who would initially spend a part of the year in a fixed settlement to utilize the artificial pastures. Such developments could also be closely related to the establishment of feedlots and a livestock finishing industry. Crops, crop residues and by-products would comprise an integral component of the linked animal-crop production system.

During more humid periods pastoralists generally attempt to build-up their herds as an insurance against hard times. Invariably, this results in over-stocking and deterioration of range conditions. Measures could be designed to purchase excess livestock, thereby reducing the grazing pressure, and to move them to areas of better pastures and with supplementary feed to fatten them for slaughter. Pastoralists are not averse to selling stock if prices are right. Such measures require the establishment of a marketing system and monitoring to prevent abuse. The system would have to be supported with improvements to stock and trade routes, with adequate watering and feeding facilities, holding grounds, finishing areas with feedlots, slaughter facilities, cold storage and arrangements for transporting the final products.

Regional specialization is a logical concomitant of the development of a livestock finishing sub-sector, whereby the arid and semi-arid area would concentrate on breeding livestock and either the moister regions or irrigated areas would specialize on fattening and finishing the animals. This too must be carefully monitored as traditionally, poor quality livestock have been purchased from the pastoralist at extremely low prices by entrepreneurs who make a handsome profit on sales after fattening. Such a system is appealing because store animals removed from the rangelands at the earliest age possible would not only increase off-take, but finishing in the areas of crop production would lead to considerable improvements in carcass weight and the quality and quantity of meat.

None of those measures could be implemented without the understanding, consent and cooperation of the social groups involved. Yet having witnessed, and in many cases been a victim of a long series of poorly designed pastoralist development projects, it will be no easy task to bring the nomad or the transhumant pastoralist into productive and sustained contact with government agencies and programs. Nevertheless, the social organization of many pastoral groups could, under the right conditions, lend itself to the establishment of pastoral producers' associations or cooperatives that could be given legal status for involvement in development programs or investment projects.

The policies for development and management of pastoral resources suggested

above are designed to use existing resources in the medium term and also to establish the basis and framework for long-term programs of livestock resource use in the arid and semi-arid zones. But before long-term development programs are designed and implemented a great amount of survey and detailed research is required as is a variety of pilot projects. The range of pastoral types, social systems and environments involved is so large and complex that generalized as opposed to more specific lines of inquiry would be of little value in either the development of the traditional livestock sector, or the ecologically sound management of drylands.

Nevertheless, several desirable aspects of long-term policies can be suggested at this stage. The complete sedentarization of nomadic and transhumant pastoralist groups is not recommended. Apart from being unnecessarily disruptive of societies and leading to the underutilization of valuable if marginal natural resources, it would probably also result in the serious reduction of meat and milk production. Partial settlement via integrated crop-livestock production schemes is, however, recommended. Schemes of this type could be based on a division of group labor; a part of the group producing fodder and feed for the animals and crops for themselves, and the others would manage the stock during the season of rangeland use. The main settlements, where farming takes place, would be occupied by the entire group during the dry season. Medical care, education and other government services could be introduced via these permanent settlements, and feedlots, slaughterhouses, and cold storage plants and processing plants located in the settlements when economically and socially feasible.

The second long-term aspect of development policy for pastoralists is stock improvement, control of animal health and livestock management, increased animal productivity and improved herd off-take. Breed and breeding improvement should be undertaken largely through selection within indigenous breeds already adapted to dryland ecosystems. Crossbreeds and exotic stock require greatly improved feeding, management and health standards that are far beyond the capacity of the average traditional pastoralist at the present time.

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