Land use and farming systems in the Horn of Africa

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Efficient land use and farming systems are essential if agricultural production is to be increased substantially in Africa on a sustainable basis. Land use and farming systems in the Horn of Africa – Sudan, Somalia, Ethiopia and Djibouti – are analysed in this article. Policy options and recommendations to improve the situation in the four countries are outlined.

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Much has been written in recent years on the precarious food and agricultural situation facing the different African countries. While the index of total agricultural production for Africa as a whole increased from 93.42 in 1975 to 110.66 in 1985 (1979–81 = 100), per capita agricultural production showed a downward trend owing to the region's growing population, which increased from 413.5 million to 555.1 million. The index of per capita agricultural production declined from 108.35 in 1975 to 95.62 in 1985. In contrast, the corresponding statistics for Asia increased from 94.85 to 111.59 and those for South America from 95.76 to 102.22.

The recent FAO study on agricultural and food problems in Africa concluded that even the present inadequate food supply situation is unsustainable.[1] Unless major policy decisions are taken and implemented to resolve the food production crisis and reduce the rate of population growth, the trends of the past 25 years will continue thus aggravating the situation during the next 25 years. Famine of the magnitude experienced during the 1983/84 drought may, therefore, become a regular phenomenon even in periods of average rainfall.

The study further concluded that, if the present trend continued, per capita food production in Africa would steadily decline and that, during the next 25 years, the level of food sufficiency would be reduced from 52% to 34% in North Africa and from 85% to 56% in sub-Saharan Africa. The cereal deficit would increase almost four-fold to 100 million tons by the year 2010. The cost of cereal imports would escalate six-fold, from the present $5000 million to $30 000 million in real terms – or double the estimated value of agricultural exports.

Africa could rise to face this critical challenge successfully if available land and water resources are efficiently utilized and other resources are properly mobilized. Land and water resources are available to meet future requirements, but not necessarily in the areas where there is the greatest need. A major part of staple food crops is likely to come from rainfed farms, some of which may need special management due to their fragility. It is possible to have a minimum, average, annual growth of 3% in staple food crop production for the continent as a whole, if land and water resources are properly used and managed.

[1] FAO, *African Agriculture: the Next 25 Years*, FAO, Rome, Italy, 1986.

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Types of land use

Land is used for a variety of purposes, many of which often compete with each other. Since the main focus of this report is on the pattern of land use relating to agriculture, the only facets of land use being considered here are those for rainfed and irrigated agriculture, pasture, forestry, national parks and game reserves.

Table 1 shows the present status and future potential of various types of uses of land in Djibouti, Ethiopia, Somalia and the Sudan. Due to the quality and extent of the data available, the figures given in Table 1 and elsewhere in this report should be considered as indicative rather than definitive.

Rainfed agriculture

Rainfed agriculture is the dominant form of land use in the Horn of Africa. Use of land, however, varies considerably in the four countries, and even in the various regions of the individual countries, due to the constraints posed by soil and water availability as well as prevailing climatic and terrain conditions.

In Djibouti, both soil and water are major constraints to agricultural production. Arable land is limited and significant amounts of fertilizers need to be applied due to poor soil quality. Water availability is seriously limited since it rains about five or six times a year for a total of less than six hours. The average yearly rainfall over the period 1961–70 was only 144 mm/year, with tremendous variations from one year to another. Because of the hot, arid climate, nearly one-third of the rainfall evaporates immediately. A combination of high temperatures throughout the year and scarce rainfall means that human activity and vegetative cover are both limited. Notwithstanding the fact that agricultural potential in Djibouti is limited, it is still far from being exhausted. On account of the arid conditions which prevail throughout the year, cultivation of crops is confined to farming under irrigation systems.

In Ethiopia, rainfed production is dominant. There are about 7 million peasant families whose holdings account for 94% of cultivated land and over 90% of agricultural production, including most food crops like cereals, pulses and oilseeds, and coffee. State farms primarily grow cotton and sugar cane. Virtually all the livestock is in the peasant sector and is grazed on communal or common land. The size of the average family farm holding is around 1.5 hectares.

Of the total land used for crop cultivation in Ethiopia, cereals account

Table 1. Land use in Djibouti, Ethiopia, Somalia and the Sudan (thousand hectares).

Type of land	Djibouti	Ethiopia	Somalia	Sudan
Total area	2 200	122 190	63 766	250 581
Land area	2 198	110 100	62 734	237 600
Arable land	–	13 200	1 050	12 390
Rainfed land	–	–	–	–
Potential	–	24 940	1 740	56 220
Actual in 1982	–	13 140	1 020	10 690
Irrigated land				
Potential	6	1 910	900	4 400
Actual in 1982	0.02	110	800	1 700
Land under permanent crops	–	730	16	58
Permanent pasture	200	45 200	28 850	56 000
Forest and woodland	6	27 700	8 950	47 700
Other land	1 992	23 270	23 868	121 452

for 70–75%, pulses for 10–12%, permanent crops including ensat (*Ensete ventricosum*) for 8–10%, oilseeds for 3% and vegetables, roots and tubers for less than 1%. With varying terrain and climatic conditions, different regions specialize in different crops. Cereals are the main staples in most of the country except in the south-western highlands where ensat is the staple food. Below 2000 m, land is used for growing sorghum, millets and – where there is enough water – maize. Teff (*Agrostis teff*) and wheat predominate at 1500–2500 m, and barley at 1500–4000 m.

The peasant sector has adopted a very simple farming system. Agricultural implements include the sickle, wooden plough or the machete, and the only energy used (other than human) is animal traction power, which is inadequate. Most peasants use an ox-drawn plough (*marasha*) which breaks up the soil, but does not turn it and is, in effect, a form of minimum tillage operation. It takes around 100 hours to fully prepare one hectare of land. Hand-weeding requirements are excessive due to inadequate tillage.

The use of fertilizers in the peasant sector is low: only about 14% of the peasants use them and some 2% use improved seeds. Under these farming conditions, yields are low and fluctuate between 0.8–1.2 tons/ha. During the 1986/87 crop season, the government planned to distribute to the peasant sector 79 017 tons of fertilizer, 32 890 tons of improved seed and 340 104 kgs of powdered pesticides together with 15 733 litres of liquid pesticides. However, over the nine months of the fiscal year, 67% of the fertilizer, 28% of the improved seeds and only 3% of the pesticides were distributed.

The Ministry of State Farm Development was established to alleviate the country's food problems, produce adequate amounts of raw material for industry, expand output for foreign exchange earnings and increase employment opportunities. The Ministry started with 58 000 ha of cultivated land in 1975/76 and this had increased to 199 934 ha by 1985/86. In the ten-year Perspective Plan, the Ministry is expected to expand the cultivated area by an additional 350 800 ha, of which 115 000 ha will be irrigated. The state farms are currently heavily mechanized and use the bulk of the country's available agricultural inputs. Production costs at state farms are substantially higher than those in the peasant sector, and their financial performance has been below expectations.

In Somalia, the main foodgrains, sorghum and maize, are mostly produced on rainfed land and occasionally on flood-irrigated land. Considerable rainfed farming occurs between the Juba and Shebelli rivers, especially in the Bay region. Most of the recent growth in grain production has been due to the rapid expansion of rainfed areas.

It has been estimated that Somalia has about 8 million ha of cultivable land, of which less than 1 million ha is presently being cultivated. An important land use issue yet to be resolved is to what extent the remaining 7 million ha of potentially cultivable land can actually be cultivated, what the division between rainfed and irrigation sectors would be and what the investment costs would be. According to World Bank estimates, expansion of rainfed farming would require investments in the order of $300/ha (1979 prices) compared to $7500/ha for irrigation development.

The average size of rainfed farms in Somalia is about 5 ha but the area farmed depends on the availability of labour during the peak demand

period of weeding. Since farmers continue to use traditional technology such as the hoe, the extent of land that can be farmed per person is limited. Foodgrain yields are low, in fact among the lowest in Africa, since inputs like fertilizers, pesticides and improved seeds are rarely used. Under these circumstances, families with more labour available generally prefer to channel it to additional livestock holding rather than to use it for crops, as the former is likely to produce better returns.

The dryland farmers, who are almost exclusively smallholders, generally adopt a risk-minimization strategy of production. Since land is plentiful, but rainfall erratic and scattered, several plots are cultivated with low plant densities in different areas. This increases the probability that crops in some of the plots can be harvested. All attempts to introduce large-scale mechanized farms in these areas have so far been unsuccessful.

Rainfed agriculture is probably the most important, single economic activity in Sudan. Depending on the rainfall, the share of rainfed production in the country's agricultural gross domestic product has varied from a high of 72% in 1981/82 (a good year in terms of rainfall) to 57% in 1984/85. During the 1981–86 period, the five-year average was 66%. It is estimated that some 14 million people, nearly two-thirds of the total population, depend upon rainfed agriculture for their livelihood.

The use of land for rainfed agriculture also plays a crucial role in the country's food security since over 80% of sorghum produced, and most oilseeds, meat and dairy products, come from such areas. While cotton yields have been poor in rainfed areas, averaging only 0.1–0.2 tons/ha through the 1970s, cotton still remains an economically attractive crop given the reasonable yields obtainable and rational pricing mechanisms. Rainfed agriculture is also an important net contributor to Sudan's balance of payments and contributes to the country's export earnings by providing 100% of gum arabic (*Acacia senegal*), seasame, karkade and melon-seed, nearly 75% of livestock and oilseeds, and most of the sorghum. If the net contribution to the balance of payments is considered, rainfed land use becomes more important than irrigated land use since this sector at present uses very few imported inputs such as pesticides and fertilizers. Futhermore, by producing nearly 97.5% of the country's fuelwood and timber requirements, the rainfed sector has prevented a further drain on the country's scarce foreign exchange resources.

While rainfed agricultural land use plays, and will continue to play, an increasingly important role in the economies of these four countries, it is also the most difficult sector for government intervention. As a general rule, rainfed agriculture is practised by small farmers who are often under-privileged and mostly illiterate. They are the least organized, and lack the resources – or access to them – for agricultural development. Their attitudes tend to be conservative, and they prefer risk-minimization strategies for good, practical reasons. Thus, even though the horizontal expansion of rainfed agriculture is an attractive option, especially for Ethiopia, Somalia and the Sudan, increasing the comparatively low, present yields will not be an easy task. In many areas, yields are actually declining for a variety of reasons, including soil erosion, decline in soil fertility due to continuous cropping, fluctuating rainfall, use of obsolete production technologies and lack of adequate research support. In the absence of extension services in the rainfed areas, it will

not be an easy task to change the attitudes and practices of small farmers. With suitable policy instruments and appropriate production, pricing and infrastructural supports, it should be possible to increase yields within a comparatively short time-frame.

Irrigated land use

In terms of formal irrigation development in Africa, the Sudan is the most important country in the Horn of Africa.[2] Currently it accounts for some 28% of all African irrigation. Only Egypt surpasses it in terms of irrigated land use. If the relative importance of irrigation is considered, irrigated areas represent 14.1% of the total land under temporary and permanent crops in the Sudan, 7.2% in Somalia, less than 1% in Ethiopia and very little in Djibouti.

In the Sudan, the first major irrigation project was the Gezira scheme, which was initiated in 1925, when some 300 000 feddans were irrigated.[3] The Gezira currently covers a land area of over 2 million feddan, which makes it probably the largest irrigation scheme in the world under a single management. The irrigation schemes were originally planned for the growing of cotton primarily as an export crop, and fodder crops were introduced in rotation in order to preserve soil fertility and to promote livestock development. Initially, dura (sorghum) used to be cultivated mainly as subsistence farming, but gradually wheat and groundnuts have appeared as the new cash crops, partly by replacing fodder and partly by the use of land previously kept fallow. In the past, an eight-course rotation was practised: cotton, fallow, dura, fallow or lubia (hyacinth bean), fallow, cotton, fallow, fallow. However, with declining world cotton prices together with the need to provide better returns to the tenants and to grow more wheat for an increasing urban population, this was considered to be an extravagant form of land use. Accordingly, over the years, the old system was replaced by a more intensive and diversified land use pattern. The designed cropping intensity now ranges from about 100% in the Managil extension of the Gezira and Rahad projects to about 66% in the Blue and White Nile pump schemes.

With the Nile water-sharing agreements of 1929 and 1959 between Egypt and the Sudan, it has been possible to develop over 4 million feddan of land for irrigation. In addition to the Gezira–Managil scheme, four other major irrigation schemes are: the New Halfa (0.4 million feddan), the Rahad (0.3 million feddan) and the Blue and White Nile pump schemes (0.4 million feddan each) which were initially private schemes and were nationalized in the late 1960s.

The total area irrigated in the Sudan has fluctuated considerably over the years, reaching a peak of 2.673 million feddans in 1935/36 and declining to 1.961 million feddans in 1972/73. An average area of 2.165 million feddans was irrigated annually during the period 1970–1984. On the basis of the latest information available for the 1985/86 crop season, the total irrigated land used for crop production was 1.651 million feddans (the average for 1979/80–1983/84 was 1.243 million feddans) and, for cotton, 829 000 feddans (the earlier five-year average was 985 000 feddans). The important factor to consider is, however, the yields of various agricultural products.

The yields of the main export crop, cotton, have fluctuated significantly during the past two decades. They declined radically from about 0.61 tons/feddan in the early 1970s to an average of 0.45

[2]Asit K. Biswas, 'Irrigation in Africa', *Land Use Policy*, Vol 3, No 4, pp 269–286.
[3]1 feddan = 0.42 ha.

tons/feddan during the 1979/80–1983/84 crop seasons. Yields increased to an average of 0.64 tons/feddan in 1984/85 but, even at these levels, the Sudan compares poorly with other countries like Egypt, where the average yield is nearly twice as much. The total area of cotton plantations remained more or less the same: an average of 985 000 feddans during the period 1979/80–1983/84 and 993 000 feddans during 1984/85. The current estimate for the crop season 1985/86 shows a decline to 829 000 feddans.

At the same time, the total irrigated area under other crops (wheat, sorghum, groundnut and millet) increased significantly (by about one-third). It leaped from a five-year average of 1 243 000 feddans (1979/80–1983/84) to 1 651 000 feddans (1985/86). During the same period, the average yield of wheat increased from 0.5 tons to 0.55 tons/feddan, but groundnut yields declined from 0.809 tons/feddan to 0.644 tons/feddan. Wheat yields in the Gezira and New Halfa schemes are low (around 0.5 tons/feddan) compared to northern regions, where they stand at 1.0 tons/feddan.

All irrigated cotton schemes in the Sudan are managed by public agricultural corporations which provide most of the inputs like fertilizers, pesticides and seeds as well as services such as maintaining infrastructures, operating field-level irrigation and land preparation. Farmers are given tenancies, with limited responsibilities for agricultural operations such as provision of labour, application of irrigation water, tending of crops, cotton picking and transportation to collection centres. The area to be planted with cotton is decided upon by the government each year. Crop rotations and timings and methods of major agricultural operations are determined by the agricultural corporations, and thus the tenants have limited control over the type and method of crop production.

Irrigation, especially flood irrigation, has been practised in Somalia for a considerable period of time, using surface water available from the country's two rivers, the Shebelle and the Juba, which originate in Ethiopia. Both rivers flood twice a year and the average annual flow of the Juba river is about 3.5–4 times the flow of the Shebelle. Some 110 000 ha of land are now under uncontrolled flood irrigation.

The first controlled irrigation schemes were developed in Somalia for large-scale private plantations by foreign investors. Later, large state farms were established in irrigated areas for settling nomads and also for increasing food production. These state farms were planned with a high degree of mechanization, even though sedentarization of the nomads was one of the main objectives. With the departure of many nomads to their traditional way of life, the state farms faced some labour shortages which led to even greater mechanization. These farms have to produce high-value export crops with good yields to be able to justify the costs of importing equipment and oil. These conditions have not been fulfilled. In general, it seems that the small farms have been more successful than the large state farms in employing more people and producing more food economically.

More recently, some minor streams have been diverted for the development of traditional, small-scale irrigation projects which have received some support from the Somali government and from a few donor agencies. Unfortunately, data on the flow regimes of small streams and wadis are mostly non-existent and, accordingly, these projects have been carried out on the basis of local experience only.

Thus, there is scope for gathering relevant, hydrological data, and then for more determined attempts to make such investments in small-scale irrigation projects more economical and efficient. Various other systems have also been developed for collecting surface water runoff and rainwater which could subsequently be used for small-scale irrigation.

The floodplains of the Shebelle have been more fully developed than the Juba, even though the Shebelle flow is less and, during low flows, its salinity levels are much higher than those of the Juba. Some 35 000 ha of land, out of a total area of 50 000 ha under controlled irrigation in Somalia, are in the Shebelle region. Irrigation efficiency is low, around 20%, indicating frequent water shortages.

Currently irrigated areas need extensive development and rehabilitation. Some of the presently irrigated areas have never been properly levelled or equipped with adequate secondary and tertiary canals. Consequently, on these poorly prepared irrigated lands it is not unusual to find even lower yields than in nearby areas. Many farmers face frequent water shortages and this does not make it easy to introduce irrigation water charges as practised in many other countries. The absence of income from such charges reduces the funds available for proper operation and maintenance of irrigation projects. In addition, farmers have no incentive to save irrigation water. Currently, there is a tax on irrigated land which is higher than the land tax on rainfed agricultural production.

Crop yields in both rainfed and irrigated lands in Somalia are among the lowest in Africa. For example, maize yields in 1981 in rainfed areas were around 0.3–0.4 tons/ha and in irrigated land 0.8 tons/ha. By introducing improved seeds and increasing the present very limited use of inputs, irrigated maize yields can be improved by 50%, to about 1.2 tons/ha.

The total area irrigated in Ethiopia in 1984 was estimated at 94 000 ha, nearly 70% of which were in the Awash Valley. This area is located near the capital, and the topographical features are conducive to development since many parts of the valley are relatively accessible. By contrast, many of the west and north-west flowing rivers like the Baro, the Blue Nile or the Setit, may have higher annual flows, but pass through deep valleys and canyons which make irrigation of extensive areas more difficult. The Water Resources Development Authority, created in 1981, is responsible for the development of the main river valleys.

Under the Land Reform Proclamation of March 1975, nearly all large irrigated enterprises were nationalized. The State Farm Corporations which were subsequently created have generally maintained the earlier cropping patterns. The main crops in the irrigated areas of the Awash Valley are cotton and sugarcane, followed by maize and sorghum.

There are some small-scale traditional irrigation systems along the banks of several rivers – the Omo, Weito, Wabe Shebelle and Konso. There are also a number of small irrigation schemes in Eritrea.

Djibouti has no perennial river. Some groundwater is available, but its occurrence is discontinuous and highly localized. Much of the groundwater is saline and would be expensive and difficult to exploit. Although an inventory of Djibouti's water resources has recently been carried out, much work still remains to be done before the data obtained can be transformed into development plans. During the period 1978–82, $9 million was used for assessing the country's water resources and for

making water available for urban and rural consumption. Six new water supply projects were proposed in the 1984–88 programme at a cost of $7.8 million.

Djibouti's irrigation potential is constrained by the inadequate availability of suitable soil and water. Some 6000 ha of land could be irrigated. Efforts made by the government have resulted in expansion of the area under irrigation from the 1976 level of 100 ha to over 800 ha in 1986. This has had a favourable impact on crop production, which rose from 50 tons in 1978/79 to over 1000 tons in 1985/86.

A water exploration survey has recently been undertaken with the assistance of the governments of the USA and the Federal Republic of Germany. The survey has identified four areas of the country with subsurface water resources that can be used for irrigation. The first source comprises of the *Weima*, *Sadai*, *Gobaad* and *Hanle* wadis. The valleys of these rivers have alluvium through which water percolates to form subsurface reservoirs. Water in these wadis is replenished by rain water in mountainous areas in the north of the country, where rainfall is estimated to be over 900 mm/year. This is relatively higher rainfall than the rest of the country receives. The valleys of these wadis are considered to be good sources of fresh rainwater at subsurface level, which can be exploited for agriculture. In the interior of the country wadi channels occur in areas which have deep deposits of alluvium. Percolation of water during rain-caused floods penetrates the subsurface rock where it can be extracted and channelled to lower levels for agricultural purposes. A third source of water constitutes sheet and gully erosion in the mountains. The water filters to reservoirs at the foot of the mountains. Water from these reservoirs can also be channelled to lower-level ground for irrigation purposes. The Plava basins comprise the fourth source. Here runoff water is supplied to the playas by the short slopes and narrow watersheds.

A centre for water and soil has been established by the government of Djibouti with the assistance of the USAID. The centre aims to achieve a number of objectives which include the establishment of capacity for analysis of ground and surface water; the cataloguing and dissemination of hydrological information; the classification of soils and the preparation of soil maps; and the evaluation of soils for proper utility. However, the centre has faced problems relating to manpower, equipment and finance. It has, therefore, not functioned to its full potential. The importance of systematic evaluation and monitoring of soil and water conditions prompts that the weakness apparent in the establishment of the institution be overcome.

Rangelands

The use of land for grazing plays a crucial role in the lives of people and the economy in Ethiopia, Somalia, the Sudan and, to a lesser extent, Djibouti. It has been estimated that nearly 60% of the Somali population practises nomadic pastoralism in a harsh environment with marginal land resources in an arid and unreliable climate. This is not surprising since nomadic pastoralism is an effective as well as a practical response to marginal land subjected to low and variable rainfall. Over a considerable period of time, the Somali nomads have developed their pastoral grazing systems and an overall rational strategy for their individual livestock management units.

The patterns of grazing rotation practised by the nomads are dictated

by natural conditions such as the availability of drinking water, the presence of feed for livestock (including minerals and salt), outbreaks of biting flies like qulbe or sibi or the presence of tsetse flies, and also by kinship ties. Even though some of the best dry season grazing areas can be found within the river valleys of Somalia, they are generally avoided if infested by the tsetse fly, the vector of trypanosomiasis. Only under severe drought conditions, when livestock face starvation, will the pastoralist consider running the risk of having them graze in such areas. As a general rule, however, the nomads prefer to herd their livestock within traditional grazing areas, *degaans*, for as long as possible. Thus, movement across *degaans* is more frequent in drier climates, with more erratic rainfall.

A mix of four major livestock types (cattle, sheep, goats and camels) occurs throughout the Somali central rangelands, although proportions vary from place to place. The animals are usually herded separately, especially in dry seasons when they require different watering frequencies and thus have to be grazed within safe distances from watering points. Women and children generally look after cattle and sheep near dry season water points, and goats and milking camels up to 20 km from such points. Young men herd camels further away from the water sources.

Reliable estimates of present livestock numbers in Somalia and the Sudan are not available. The Ministry of Planning in Somalia has estimated that in 1984 the country had 5.1 million head of cattle, 6.1 million camels, 13.6 million sheep and 17.1 million goats. The livestock subsector dominates the agricultural sector in Somalia at present and it is unlikely that rangelands can sustain, on a long-term basis, the increases in livestock required to provide a livelihood for the nomadic population which is currently increasing at the rate of 2.2% per annum. In fact, a key policy issue for Somalia's future development has to be how to absorb the additional nomadic population productively, without exceeding the carrying capacity of the land.

Under the existing land tenure systems in Somalia and the Sudan, communal grazing of livestock is the rule rather than the exception. Accordingly, rangelands provide the bulk of livestock feed: around 85% in the Sudan and a somewhat higher percentage in Somalia. The fact that the human and animal population has increased at a high rate in recent years has entailed overgrazing of the rangelands, which has had a negative impact on agricultural production. This is partly due to improved human and veterinary health care, to a partial control of killer diseases and to the suppression of tribal warfare.

An important policy issue for Somalia is how to obtain enough forage from the rangelands on a sustainable basis without exceeding their carrying capacity. Overgrazing is a serious problem, though the Somali nomads are good at using the different pastures available to the maximum benefit of their livestock. With increasing numbers of livestock, the competition to use the same grazing areas has intensified, and it has thus been impossible to prevent overgrazing since the pastures are communal. The earlier informal agreement whereby certain areas were reserved for grazing during *jilal* (the hot arid season, from December to March) and others during *hagai* (the cool season) has now mostly broken down. It is now generally accepted that few, if any, rangeland reserves are available in Somalia which could be used to reduce population pressure in the presently overgrazed areas. There is

uncertainty about the equally realistic possibility of increasing forage production in the currently used rangelands as the costs of implementing such measures are not known.

Ethiopia has one of the largest livestock populations in Africa, both in absolute number and on a per capita basis. This sector, however, does not make a contribution commensurate with its size to the national income. There are many reasons for this disparity, including the low production potential of indigenous breeds, poor nutrition, the absence of good year-round pasture, the high incidence of disease, inadequate government services in education, training, extension work and research, limited credit availability and undeveloped domestic and export marketing practices. It is estimated that the 1983/84 drought contributed to the death of some 1.5 million cattle which further weakened this sector.

Grazing is almost the only method of feeding, and grazing conditions are unfavourable during a major part of the year. In the dry season, stock watering is a serious problem in most parts of the country. Livestock numbers are excessive in some areas, thus contributing to overgrazing. Areas near watering points are often overgrazed, with attendant accelerating soil erosion and environmental degradation.

The Ethiopian government has recognized the importance of this sector, but the lack of trained manpower in all areas is a serious constraint. Some projects are experimenting with new institutions such as of Pastoral Associations and Service Cooperatives which are expected actively to involve pastoralists in the management process.

The use of rangelands in the Sudan has also created environmental problems due to the imbalance resulting from rapidly increasing livestock forage requirements on the one hand, and the reduced carrying capacity of land used for grazing on the other. Against a background of rising human and livestock populations, and the combined effects of agricultural encroachment and fuelwood harvesting, the Sudanese rangelands have come under tremendous pressure. The extent of this increased pressure can easily be demonstrated: between the period 1957–77 the human population increased more than six fold, the number of cattle twenty-one fold, camels sixteen fold, sheep twelve fold and goats eight fold. While, in normal years, livestock owners have some degree of flexibility as to whether to release or retain the animals on the rangelands, there do not appear to be any practical solutions at present to the discontinuity and instability caused by drought.

A study in 1985 by the Ministry of Agriculture in the Sudan indicated that the country's available range and forest land was approximately 279.4 feddans, or nearly 50.2% of the total area. Total seasonal forage production from the usable rangeland was estimated in 1979 at about 77.7 million tons, which could meet grazing requirements of 22.1 million Animal Units (AU). The livestock population in 1980/81 was estimated at 27.7 million AU, which means that some 5.6 million AU could not be supported on a long-term, sustainable basis.

An improper use of rangelands has contributed to desertification in both Somalia and the Sudan, although reliable estimates of desertified land are not available. Anecdotal evidence in Somalia indicates that it is fairly common to find patches of sand dune in places where they did not exist a decade ago. A decreasing population of *yicib* (*Cordeauxia edulis*), an important dry-season browsing source in part of the central

rangelands, which also produces nuts suitable for human consumption, is another example. Similarly, in the Sudan, the semi-arid and savannah belts are subjected to desertification. Environmental degradation of land due to improper use will be discussed later.

Lack of basic information on the various components of rangeland–livestock–human interactions, and of a proper understanding of the dynamics of their interrelationships, including the existing social, cultural, economic and environmental characteristics, are major constraints which have partly contributed to inappropriate and unsustainable project designs in the past. Thus, not surprisingly, most projects have failed to deliver all the benefits initially anticipated. Better and broader understanding of the significance of agropastoralism, including its agronomic, environmental and anthropological implications, is a prerequisite for improved project design and implementation if encouraging results are to be anticipated.

In Djibouti, with the prevailing high temperatures and water scarcity, vegetative cover consists of those plants which can sustain such extreme conditions. Accordingly, for livestock development, extensive migratory grazing is necessary, provided watering points can be made available in strategic areas. The country is estimated to have 500 000 goats, 350 000 sheep, 50 000 camels, 40 000 cattle and 6 500 donkeys. These provide the livelihood of the nomadic population, estimated at 65 000. There is not much marketing of livestock products in the country. Virtually all live animals and salted hides passing through the port, and animals slaughtered in Djibouti, come from Ethiopia.

Land used for forestry

The countries in the Horn of Africa face problems in the area of forestry similar to those arising in other sub-Saharan countries. The aggregated impacts of pressure on land supporting increased human and animal populations, periodic drought and failure to manage forest lands on a sustainable basis have contributed to large-scale deforestation and consequent land degradation. Moreover, uncontrolled exploitation of forests, either for agricultural expansion and/or extraction of forest products, including fuelwood, has resulted in the 'mining' of forest resources. Effective policies aimed at afforestation and forest conservation have been lacking, or are being poorly implemented, and consequently there has been a serious erosion of the overall forestry resource base. Clearly, the pressures to meet the increasing demands for forest products, to convert existing forest lands to those used for agriculture and livestock grazing purposes while simultaneously preserving existing forest reserves, present the governments with a policy dilemma which will undoubtedly prove to be a most difficult challenge over the long term.

At present, in all the countries being considered, there are many constraints which hinder the rational use of land for sustainable forest management. Among these are the lack or shortage of: a reliable and readily accessible database on forestry; estimates on present and future production and demand for various forest products; an up-to-date legislative framework which properly reflects the multi-faceted pressures faced by forests and poor implementation of whatever legislation is available; suitable, managerial and professional local staff, and the level of financial resources available to the forestry sector. These fun-

damental weaknesses have contributed to the lack of coherent policies on all aspects of forest management.

In Djibouti, forests and woodlands have been estimated to cover about 6000 hectares. The mountains located to the north of the country receive adequate rainfall at higher altitudes to sustain forests. These forest areas are somewhat limited, covering only some hundreds of hectares. There are also some doom-palm groves. At present, this forest and the palm groves are used primarily by transhumant flocks and herds.

Much of the extensive forest which once covered Ethiopia has been recently lost due to the expansion of agricultural production and the exploitation of forest products without compensatory reafforestation programmes. It is estimated that forests have declined from 40% of the country's land area at the turn of the century, to 16% in the early 1950s, to less than 4% at present. Currently, Ethiopia is continuing to lose about 200 000 ha of forest area per year.

In Ethiopia, most of the remaining forest is located in the south-western and south-central parts. An inventory made in 1979 indicated there was an area of 2.4 million ha covered by high forest. However, since this analysis was based on aerial photographs taken during the 1950s and 1960s, the figure is bound to be high. Around 850 000 ha of these forests were at 1600–2400 m altitude and were dominated by softwoods. Open savanna-type woodlands, dominated by acacia species, cover about 28 million ha. Land in these areas is also used for grazing and agricultural production. In the western part of the country, bamboo covers an estimated 450 000 ha.

While the initial impetus to deforestation in Ethiopia came from food requirements for an expanding human and animal population, a major cause at present is fuelwood requirements. Ethiopia is among the least energy-intensive economies of the world, and 90% of the energy used for household purposes is derived from biomass – fuelwood, charcoal, agricultural residues and dung. In 1982, about 90% of all energy supply came from renewable sources, and this was equivalent to about 24 million tonnes of air-dried wood or 8 million tonnes of oil per year.

In 1982 it was estimated that the mean annual increment in production of all forest resources could satisfy only 40% of the demand for fuelwood. Such shortages have meant a substantial increase in fuelwood prices in urban areas, and in rural areas dung and crop residues are used for cooking, thus eliminating their potential use as fertilizer and animal feed. More than 90% of all cattle dung in rural areas is collected for fuel. In Addis Ababa, fuelwood prices per tonne have risen from Birr 40 in 1975 to Birr 180 in 1983.

If adequate reforestation is carried out in Ethiopia in 1987 so that the projected fuelwood demand can be met by 1992, it is estimated that some 512 000 ha of fuelwood plantations has to be established to satisfy the urban demand, and another 2.3 million ha for the rural demand. The cost of a reforestation programme to satisfy the rural fuelwood needs has been estimated at Birr 3 billion at 1982 prices, plus 1.31 million man-years of labour. The World Bank estimates that the achievable targets are 195 000 ha for urban supply and 960 000 ha for rural supply, at costs of Birr 403 million and Birr 343 million respectively.

In Somalia, overall available forest resources are adequate to satisfy national needs since total aggregated natural regeneration exceeds

demands for forest products and fuelwood. These demands, however, are met from accessible forest areas because of lack of road networks and inadequate transportation systems. If accessible forests only are considered, their growth would amount to around 20% of all national forest growth and this is contributing to a serious imbalance between growth and demand in specific areas. The total accessible forest area is now assumed to be around 10 million ha with a mean annual growth of about 0.36 m^3/ha. A heavy demand for fuelwood, charcoal and house construction, grazing requirements for livestock, and land requirements for settlements and agriculture have been responsible for serious deforestation over extensive areas near population centres, including the refugee camps. The problem is now serious in the dense savannah areas.

While energy consumption in Somalia is low – around 0.2 tonnes of oil equivalent (TOE) per capita in 1984 – most of it is in the form of fuelwood and charcoal. Government estimates indicate that total fuelwood consumption in 1984 was 5.6 million m^3, amounting to an average annual per capita consumption of about 0.96 m^3. (World Bank estimates for 1984, however, are 4 million m^3 and per capita consumption of 0.6 m^3/year.) Progressive deforestation near towns means fuelwood and charcoal have to be collected and transported over increasingly longer distances, and this is contributing to increasing prices, environmental degradation and time required by rural women and children to collect their daily requirements. Charcoal supplies for Mogadishu are now coming from the Bay Region, some 350 km away.

A low and erratic rainfall and inhospitable climate have not helped promote afforestation, which has not exceeded 100–200 ha/annum in recent years. Present estimates indicate that annual fuelwood production from rainfed plantation projects is unlikely to be economically viable since establishment costs are around $1000/ha and fuelwood production is about 4 m^3/ha/year.

The land available for forestry is also under pressure in the Sudan. It is estimated that clearance of forest land to expand the agricultural area, harvesting of fuelwood and other forest products, and overgrazing, have reduced the country's forested area by nearly 20% over the past two decades. Some 40 million m^3 of fuelwood are now harvested annually from savannah areas to provide the basic energy needs of about 75% of the Sudan's population. This accounts for nearly 82% of the Sudan's total energy consumption.

As in Somalia, forests in the Sudan are disappearing, particularly near cities, towns and villages. The natural Savannah vegetation surrounding major cities like Khartoum has largely disappeared due to constantly increasing demands for fuelwood. Charcoal is currently being transported over a distance of 500 km or more to the main urban centres.

Conflicting demands for land use in natural woodland savannah from fuelwood production and grazing requirements is making sustainable management of the forest areas difficult. Livestock grazing requirements are now exerting tremendous pressure on rangelands and savannah. Nomadic herds often contribute to overgrazing since their feed requirements exceed the carrying capacities of these areas. Traditional solutions like controlled and rotational grazing have not so far been successful with nomads, especially in drought years.

A special problem in the Sudan with reference to land use has been the establishment of mechanized farming schemes on previously

forested areas. These large-scale land clearance operations have completely removed all trees, including those which would have been sources of seed. These schemes now cover some 4 million ha. Since, under existing regulations, forest land converted to agricultural development can be abandoned with impunity, some of it has now been abandoned after only about 3–4 years of continuous sorghum production. The purely exploitative nature of these operations has meant that the idle land areas have not regained their vegetative cover due to erosion of top soil and disappearance of seed sources. The natural fertility of the soil has declined, which makes afforestation a more difficult, time-consuming and expensive process. According to the Forestry Commission, not more than 28 500 ha of such land had been reforested by 1982. Since the original promoters have no obligations towards reforestation, rehabilitation of abandoned land has been a slow process. Currently, the policy in the Sudan is to slow the horizontal expansion of mechanized farming schemes: the emphasis instead is on yield improvement.

If the present deforestation process in the Sudan continues uncontrolled, an additional 10 million ha of savannah woodland in the north, representing about two-thirds of the remaining resources in the region, would be lost by the year 2000. This would mean the displacement of at least 30 000 nomadic families, accounting for some 6% of the total nomadic population of the country, and their livestock. The average haulage distance for fuelwood and charcoal to Khartoum and to urban centres in the Central Province would increase from 500 km to 1000 km, which would further intensify the currently emerging fuelwood supply crisis in the north. The average cost of fuelwood would increase, which would further degrade the quality of life of the poor. Total elimination of on-farm trees and shelterbelts would necessitate the use of agricultural residues as fuel. This would lead to the reduction of organic matter in soil, which is likely to reduce crop and livestock yields by 15%. Wind erosion and desertification would increase, and so would the siltation in the reservoirs. Imports of manufactured industrial wood products would increase to $50 million annually. It would also mean that the Sudan would be faced with an enormous investment programme in the future. If the estimated 20 million ha of forest which is expected to be lost by the year 2000 is to be replaced, investment of at least S£1500 million would be required which is beyond the financial resources of the government at present.

National parks and game reserves

Use of land for national parks and game reserves is an important component of wildlife preservation and tourism development policies, both of which need more attention and further consideration in Somalia and the Sudan. The two countries have some of the most abundant and diverse wildlife stocks to be found in Africa. This, plus the facts that both countries have large areas of marginal land, sparse human population concentrations and a relative lack of other exploitable natural resources, means that considerable potential exists for wildlife management and tourism development. These could offer some of the most promising possibilities as essential components of future economic development, as accomplished in countries like Kenya. This would, however, require more investment in infrastructure development.

In Somalia, the Juba and lower Shebelli regions are the best for

wildlife, but Galgudud, Bakool, Mudugh, Bari and West Galbeed are important areas as well. Many species, like the dugong, dibatag, baira, wild ass, Pelzeln's gazelle, the greater Kudu and the sea turtle are either unique to the country or rare in other countries. More than 600 bird species and 100 species of mammal can be found in Somalia. Hunting and trapping are illegal, but poaching is a real problem and is the only way in which wildlife is exploited at present. The National Range Agency is in charge of the 11 game reserves which have been authorized, but so far only Bushbush and Mandera have been developed to some extent. In the absence of entry fees, the game reserves do not generate any resources and consequently, adequate investment is not available for their management and development.

Sudan also has national parks and game reserve areas. The Southern National Park, which was established in 1939, is the largest in Sudan (1.6 million ha) and one of the largest in Africa. Since this park is located in a sparsely populated area with marginal soil and high tsetse infestation, wildlife management and tourism could form an appropriate type of land use. Even though the park was established some five decades ago, it has never been properly developed. Sudan also has many game reserves, some of which are very large like the Boma Plateau Reserve (estimated at 25 000 km^2). These reserves have not been properly demarcated and effective protection against poaching and other illegal activities has yet to be instituted. Adequate maps of these areas are not available. Field surveys and basic ecological studies are necessary to generate basic data so that proper management plans can be formulated.

Wildlife in both Somalia and the Sudan is threatened because it competes for land use with pastoralists and farmers and their livestock. Predators are often shot or poisoned because of crop damage, competition for grazing land, or merely as a means of obtaining free meat. These factors, plus illegal poaching, are threatening many species with extinction. An example is the white rhinoceros, which has virtually disappeared from the Nimule National Park in the Sudan even though the Park had earlier been renowned for this animal.

Aspects of land use

Land use planning is undoubtedly a complex issue but when land is used for subsistence purposes, as is the case in many parts of the Horn of Africa, issues and problems become even more complex. There are many fundamental factors which finally dictate how land will be used. Among these factors are: physical parameters like soil, water and climate; population; environmental conditions; culture and tradition; level of technology; planning capability; tenurial arrangements, and socioeconomic considerations. These factors vary from country to country and, often, from one region to another within the same country. Similarly the problems, requirements and development needs of farmers and pastoralists can differ from one area to another. In spite of these diversities, however, there are some important similarities between the various aspects of land use and farming systems in the countries being considered which enable one to make some meaningful and specific comments on certain important aspects.

Population–land use interrelationships

Although population density in the countries is sparse, per capita

availability of arable land and land under permanent crops by mid-1984 was 0.33 ha in Ethiopia, 0.2 ha in Somalia and 0.58 ha in the Sudan. If arable land, land under permanent crops, permanent pasture, and forest and woodlands are all considered, per capita land availability increases to 2.1 ha in Ethiopia, 7.43 in Somalia and 5.47 ha in the Sudan. The fragile environment and the limited carrying capacity of the land in the greater part of these countries make their high population growth one of the major development problems they face. Population growth rates in Djibouti, Ethiopia, Somalia and the Sudan were, respectively, 2.9%, 2.8%, 3.1% and 2.9% over the period 1973–84. These growth rates imply a near doubling of the 1980 population levels in the countries by the year 2000. Continuing population increase is a principal cause of overstocking in the rangelands. It is also a cause of the extension of arable farming to semi-arid light savannah lands in both countries. As discussed elsewhere in this report, this has contributed to desertification of large areas of the northern, eastern and western regions of the Sudan.

A Sudanese government study team on desertification has cited population increase as being a root cause of the malpractices resorted to by the farming community. Outstanding among these has been the extension of cultivation to the country's more arid zones. This has led to the encroachment of sand dunes, particularly in the northern and western parts of the country. Mechanized farming in the Kordofan area, and extension of arable farming in the Kordofan and Dorfan regions, have had disastrous consequences for the environment in these areas. Deforestation, which is occurring as a result of the quest for fuelwood and agricultural development requirements, has been a contributory cause of desertification. These issues will be dealt with in more detail later. Suffice it to say here that the governments of Somalia and the Sudan must address population issues in relation to the impact they have on land use patterns and the environment.

It is estimated that two-thirds of the 1986 Djibouti population of 456 000 lives in and around the capital of the country. Another 10% lives in interior towns. The rest of the population amounting to approximately 20% lives a nomadic life moving from one area to another in response to range conditions. The developmental problems facing the country arise predominantly from the limited natural resources available in the largely arid country.

In terms of population–land use interrelationships, both the human and the animal population should be considered since both compete to use the land. Needless to say, there is some correlation between human and animal populations. As a main source of animal protein, the number of domestic animals has increased in line with the higher demand for animal products and services arising from the increasing human population. In contrast, the wild animal population has tended to decline as the animals are hunted for their meat and for other commercial attributes such as elephant tusks and rhinoceros horn, or as their habitats are gradually destroyed as the land is used for agricultural or pastoral purposes.

Land use planning

Systematic land use planning approaches have not thus far been adopted in Djibouti, Ethiopia, Somalia or the Sudan. All the four governments have initiated a few *ad hoc* land use planning activities. These efforts have resulted in the compilation of data on certain aspects of soil,

climate, hydrology and environment in some selected areas. A few maps providing information on rainfall and soils are available. There have also been ecological surveys through which valuable data on range ecologies have been collected.

There is a considerable awareness within the Somali Government of the desirability of developing detailed data inventories on soils, surface water, groundwater, temperatures and land use in the country. This has motivated the government to seek the assistance of UNDP and UNEP to finance and implement a comprehensive land use study over the period 1987–91.

In the Sudan, detailed soil and groundwater data are available on the irrigated areas of the country which, to date, account for about 50% of agricultural output. Soil maps and hydrological data relating to the White and Blue Nile Rivers and their principal tributaries are also available and can be utilized for agricultural development planning. The problem, however, still remains for those large areas in the country comprising a wide variety of savannah lands which have considerable potential for agricultural and livestock development, but which are also environmentally vulnerable. In these areas, agricultural land use has to be introduced with caution. Large areas of this category of land have already been encroached upon by the desert. Some land use studies have been initiated by the Sudanese Government in the Dorfan and Kordofan regions. Lately, the government established a high-level Land Use Commission which has comprehensive terms of reference covering the compilation of data on natural resources, environment, hydrology and soils. Its terms of reference included responsibility for coordinating the formulation of plans for the utilization of land and natural resources in the country. It has also been assigned to coordinate the management of land and natural resource use. The Commission is to be an autonomous body which will be serviced by a Secretariat to be established in the Office of the Minister of Agriculture.

In all the four countries, the governments have broadly allocated land resources to various uses. Because of the limited data on soils, water, climate and social factors, these zoning activities have not been carried out systematically or comprehensively. Recently, conflicts have arisen over the utilization of the various land categories. The compilation of more detailed information should provide a basis for the review of those land use decisions which have been made in the past.

Land tenure

Land tenure is one of the major considerations for the restoration, conservation and management of any land-based ecosystem. Traditional communal tenure, which is generally practised in Ethiopia, Somalia and the Sudan by pastoralists, is usually incompatible with long-term sustainable management, especially when both human and animal populations are increasing, and has often been the main contributory cause of rangeland degradation. This is because, as both human and animal populations continue to increase, at a certain point in time they exceed the carrying capacity of the land. When this occurs, people are unwilling or unable to adjust the stocking rate to the grazing capacity of the area. Coordinated control is prevented by two characteristic features of such land use:

- absence of any institution or recognized owner(s) with authority to

manage the area as an integrated ecosystem, and who could successfully control the stocking rate;

- lack of clearly defined and agreed-to boundaries within which a controlling authority could exercise required management practices.

The land tenure pattern in Ethiopia was radically altered by the Proclamation of 4 March 1975 which made all rural land public property. It eliminated landlords as a class and gave the tenants the right to the land. Usury and renting were also made illegal. While access to land is now on a more egalitarian basis, and the peasants have their property rights established, factors such as the lack of complementary institutional and infrastructural facilities, timely availability of agricultural inputs including credit, and efficient farming technology have kept farm yields low.

In Somalia, under the land tenure law of 1975, all land belongs to the state, and the Ministry of Agriculture is authorized to issue 50-year leases which are both renewable and inheritable for specific parcels of land. A maximum of 30 ha of irrigated land, 50 ha of rainfed cropland and 100 ha of land for plantations can be leased. If land is left unproductive for two consecutive years, the state can confiscate it. Leases cannot be sold. Under the law, authorities are to inspect and map the leases and review them if there are any objections. Since there are thousands of leased enclosures in each district, the government lacks sufficient resources and manpower to inspect and correctly map them, or to enforce the requirement that land has to be confiscated if left unproductive for two consecutive years. Many of the existing 'leased' enclosures are not licensed, but ownership is generally respected by the local community under the traditional system. Thus, land tenure is under both legal and traditional arrangements.

The ownership of land in the Sudan is also vested with the state. Tenancies were allocated for irrigated land when the schemes were first developed, which in the case of the Gezira was as far back as the 1920s. Legally, tenancies cannot be transferred or sold, but are passed on from parent to children. In reality, however, a survey of the Gezira in 1972 indicated that 75% of all tenancies were half-tenancies, and sharecropping arrangements were widespread. Thus, although tenants on the original list may be *de jure* tenants they may not be the people who are actually working on the land.

Under the provisions of the Investment Act of 1980, the Sudanese Ministry of Finance was empowered to 'allot' land. In practice, regional government officials had considerable authority to allot land, and the Ministry of Finance subsequently confirmed such allotments. However, following the April Revolution, the Transitional Military Council declared that henceforth all land in the Sudan – whether registered or not – belonged to the State.

In the areas of the Sudan where irrigated cotton is grown, tenants may hire 70–80% of total labour requirements. Since considerably less labour is required for livestock production, livestock rather than crop production is becoming an increasingly attractive economic option to tenants. The situation is more attractive in New Halfa where many nomads have been settled. They have a continued interest in livestock and are more knowledgeable about livestock than about crop production.

It is interesting to note that the Steering Committee established by the

Sudanese Government to prepare a strategy for the development of rainfed agriculture, recommended that in late 1986 all existing mechanized farms should be surveyed and their ownership rights registered. Leases would be granted for a period of 25 years, but leases would be extended on an annual basis subject to certification that the 'user rights have not been sub-let or fragmented and that the standard land improvements (shelterbelts) have been made and recommended rotation is followed'. The lease would be openly auctioned after 25 years, but the existing leaseholder would be entitled to a discount of 10% of the auction price as compensation for land improvements made. All leases would be standardized at 500 feddans. If this recommendation is accepted and implemented, it will mean a radical change in land tenure patterns which is likely to be beneficial.

Overall, for Somalia and the Sudan, surveys of ownership rights, of land as well as crops and trees, are necessary as the present systems are not very clear. Sometimes the traditional tenure system may prevail and, at times, this system may run counter to formal legislation. For land use planning and for project designs on various aspects of land use it is essential to have a proper information base on the present situation in terms of land tenure.

Land in Djibouti is owned by the state. However, where suitable land is identified, access to land for agriculture is relatively easy. Suitable land for agriculture is in limited supply; it is determined by suitability of soil and availability of water. The ministries of finance and agriculture have jointly established a centre to provide cadastral service. The centre provides services to members of the public who declare the intention to establish small farms. When such a desire is indicated by an individual, the National Agricultural Service carries out an evaluation of the suitability of soils and availability of water suitable for irrigation. If these evaluations establish that the parcel of land is suitable, approval for allocation of land to the applicant is given by a committee of officials of the Ministries of Finance and Agriculture. To date certificates for occupation of land are for temporary occupation. Considering the large investment costs incurred in developing small farms in Djibouti, it is necessary for a review of policy on tenancy.

Many Djiboutians who have been allocated small farms do not live on the holdings. They have become absentee landlords who leave the management and operation of the holdings to paid workers. The farm allocation screening mechanisms should be improved to ensure the selection of applicants who will become the real managers and operators of their holdings.

Land degradation

Any serious attempt to formulate rational land use policies and subsequently implement them must take into account not only physical factors (land, water, biota and climate), but also environmental, social and economic characteristics and the institutions through which these policies will be formulated and implemented. In addition, land use policies should be flexible and dynamic, so that policies and priorities can reflect changing conditions.

One issue which has not received adequate attention is the short- and long-term environmental impact of land use patterns. While reliable data are not available, and the methodological problems of evaluating and quantifying the extent and level of land degradation problems are

complex, all the indications are that present and past land use patterns have contributed or will contribute to serious land degradation problems in many areas. For example, it is estimated that Ethiopia loses as much as 2000 million tonnes of soil annually due to erosion, which is equivalent to a soil depth of one metre over an area of 19 000 ha that could feed a minimum of 66 000 families at the current average food consumption level. At the national level, 5 million ha of land is seriously affected by erosion, sedimentation and drought problems.

In Ethiopia, Somalia and the Sudan, the signs of land degradation problems can be seen in many areas due to improper patterns of land use – eg sand dunes can now be seen in areas where they did not exist a decade ago; populations of desirable vegetation (eg *Yicib* in Somalia) are decreasing due to overgrazing. Use of inappropriate farming practices on comparatively fragile or marginal land, and progressive deforestation for the various reasons discussed earlier, are responsible for increasing soil erosion from wind and water, declining soil fertility, reduced water-holding capacity in soil and increasing sedimentation in water bodies. These environmental degradations together with higher human and animal populations are tending to magnify the overall impacts of recurring drought. All these signs are clear indications of the fact that the carrying capacity of land in the affected regions is declining.

In Somalia, the establishment of dense areas of agropastoralism has caused localized desertification. It is now considered that the active sand dunes in areas around Bargan, Hareeri, Gal, Garable and Jacar were all formed as a result of intensive agropastoralism practised some 30–200 years ago. New boreholes, introduced with the best of intentions, have often contributed to accelerated desertification. Each new borehole, ie a permanent source of water, drew a sudden influx of agropastoral activities into the surrounding area. Land clearance for agricultural activities and overgrazing around these water points are directly responsible for extensive wind erosion and desertification. Examples of this phenomenon can be seen in villages like Bagan, Galead, Gal, Hareeri, Jacar and Nooleye. Sand dune formation in Nooleye was first witnessed in 1980.

In the Sudan, land degradation is a serious problem. A 1985 report by the Ministry of Agriculture has estimated that drought and desertification are now threatening 4 million feddans of irrigated land, 5.5 million feddans of rainfed mechanized farms, and 16.5 million feddans of traditional rainfed agricultural land. Desert encroachment is also threatening almost 241.8 million feddans of forest land and Sudan's production of gum arabic which in the past has amounted to 8–9% of the country's total exports.

Extensive farming of rainfed marginal land in the northern Kordoufan, Darfour and White Nile areas has contributed to desertification, as a result of which the movement of sand dunes has accelerated. In the northern Kordoufan and northern Darfour regions, shifting sand dunes are now covering formerly productive sandy-clay soils. The area between Delgo and Karima along the River Nile is now subject to serious dune encroachment.

Policy options and recommendations

On the basis of the analysis carried out, the following policy options and recommendations are suggested.

Development policy and planning capability

Land use planning should be considered an integral part of development planning. While few African countries had carried out or even attempted national planning prior to independence, there is an increasing interest in and emphasis on macroplanning with a view to promoting better use of the limited resources available to achieve prescribed national objectives. At the macroplanning level, there is generally adequate knowledge, information and experience, but at the micro- or operational level the situation is often the reverse. The type of information necessary at this lower planning level often does not exist, and qualified professional manpower is in short supply. Thus, even when reasonable macroplans are available, it does not axiomatically follow that similar quality microplans can be formulated.

Furthermore, good land use plans can only emanate from well-formulated policies. It follows that land use plans formulated in a vacuum of non-existent or poorly articulated policies cannot meet long-term national needs. It is, therefore, essential that policy and planning capabilities should be built up and this process should receive priority attention.

At present, it is unclear how the responsibilities for the various aspects of land use and farming systems are allocated between, and within, sectoral ministries and other government and private bodies. This lack of coordination gives rise to many serious problems, including gaps in coverage where no ministry or agency has adequate presence, unnecessary duplication of effort, and contradictory approaches or statements emerging from the various governmental bodies which leave the public more confused than enlightened. Lack of appropriate land use legislation and poor implementation of existing legislation further complicate the situation. It is, therefore, proposed that greater emphasis be placed on appropriate policy adjustments and reforms which reflect the present realities in the area primarily based on the needs of the small farmers. Governments should consider establishing an effective coordinating mechanism, preferably in the Ministry of Planning. Furthermore, such a mechanism, once established, must have the authority to coordinate land use planning and be supported by up-to-date, realistic legislation to ensure that overall planning efforts are respected and not circumvented, and that the land use decisions made are binding at all levels of government. Coordination between the central government and regional bodies should be further encouraged.

Resolution of land use conflicts

The absence of a coherent land use policy has created some confusion and has, to a certain extent, contributed to the development of conflicts between competing users of land. In the Sudan, for example, mechanized farmers have cleared forests and destroyed wildlife habitats and have also encroached upon the lands generally used by pastoralists and traditional farmers. This latter group, in turn, has increased pressure on existing forest lands from the search for fuelwood, fodder and new areas for cultivation. Domestic animals belonging to pastoralists have intruded upon areas of land used by farmers engaged in irrigation. Overall forests and wildlife habitats are under pressure from all other land users as well.

While there will always be a demand for land from competing users, a national land use plan is urgently required which properly matches the

various principal characteristics of land – such as soil quality, water availability, climatic and socioenvironmental considerations – with the proposed type of land use. Once the suitability of specific land areas has been determined on a scientific basis, decisions consistent with long-term national needs can be made on how these areas will be used. If and when such plans exist, attempts will be made to use the land in the manner for which it is most suited. While some land can be used for various purposes, the presence of a review process, and the enforcement of appropriate legislation referred to earlier, will contribute to a more optimal use of land resources and a significant reduction in conflicts over various land uses.

Rainfed agricultural land use

Even though rainfed agriculture dominates the land area under crops, in the past many development efforts were concentrated on irrigated crop production. This is particularly noticeable in the Sudan which has extensive irrigated areas. Because of this, rainfed production has been increased primarily through horizontal expansion which has proved relatively inexpensive and, in the Sudan, has often been unrestricted under the prevailing traditional land tenure system and due to an unrealistic perception of the availability of plentiful land resources.

In view of the fact that rainfed agriculture offers the highest comparative advantage with the least dependence on foreign exchange, an important policy implication is the maximization of rainfed production, especially through yield improvement. The traditional rainfed farmers are underprivileged, mostly illiterate, lack resources and are the least organized and the least capable of taking risks. This makes rainfed agricultural land use difficult to implement through suitable policy interventions. Also, since the rainfed sector is virtually all in private hands and is thus market-oriented, the role of the private sector – at least in this context – has to be supported and encouraged.

In the same way, policy interventions are necessary not only to prevent the decline in soil fertility but also to restore it through appropriate crop rotation and land use practices. Research, development and extension work are necessary in order to replace old crop varieties with new strains which are more drought-tolerant and require shorter maturing periods.

Irrigated land use

In Somalia and the Sudan especially, irrigated land use has played an important role in increasing the production of cereal and export crops. Irrigation efficiency in all four countries is still low, and there is still scope to improve present water use practices by proper management. Rehabilitation of existing irrigation schemes is a priority area, since the most immediate prospects for rapid production benefit and early and higher economic returns will generally lie with the rehabilitation of existing irrigated areas rather than with new construction. Accordingly, from the viewpoints of economic efficiency and national income distribution, it is necessary to develop a policy based on an appropriate mix of rehabilitation and construction of new, small-scale irrigation projects. It is essential to overcome the problem of lack of trained manpower partly through incentive-oriented managerial policies and practices. Since the development of skilled manpower is a long-term process, relevant policy and planning strategies should be adopted as

soon as possible to utilize existing manpower effectively and to encourage young people to aquire the requisite skills.

Small-scale irrigation projects have not received adequate attention in the past. As they do not require major investments in physical infrastructure, and foreign exchange requirements – if any – are low and can be developed fairly quickly and at low cost, small-scale projects can be cost-effective for a wide variety of crops, including basic staples.

Rangelands

Rangelands play an important role in the economies of Ethiopia, Somalia and the Sudan. The major problem has been the deterioration of range vegetation in areas where animal populations exceed the carrying capacities of the land. Reversing range degradation, and increasing, or at least stabilizing, livestock production will not be an easy task under the existing systems of land use and tenure. More information is necessary on the technical, sociological and economic aspects of traditional grazing systems so that appropriate policy interventions can be made to improve them.

It would be desirable to execute pilot projects on different forms of grazing management which would not necessarily be limited to systems presently in use. This should be effected in close consultation and collaboration with the pastoralists. The extent to which formal grazing management can play an important role in the two countries has yet to be determined. It may, however, be necessary to consider some form of rest-rotation grazing to upgrade highly deteriorated land areas.

Forest land management

Progressive deforestation in Ethiopia, Somalia and the Sudan has serious economic, social and environmental repercussions over the long term. In addition to the factors discussed earlier, management of forest land has been largely ineffective for two other reasons. First, the overexploitation of accessible forests has been possible because of the lack of real commitment by the governments to control it, and the fact that short-term, tangible gains have outweighed the long-term social and environmental costs. Fortunately, this attitude has started to change in recent years.

The second reason has been the absence of appropriate technical packages for reafforestation of marginal land in arid and semi-arid areas. Recurring drought, the general dearth of good soil presently available for tree planting, and the lack of adequate infrastructure have created a situation wherein it is unlikely that large blocks of plantations can be developed within a limited time period. The situation, however, is not all bleak. For example, within the 63 000 ha of the northern sector of the Gezira scheme, there are 110 km of major canals, 54 km of branch canals, and 3000 km of minor canals. If shelterbelts are developed extensively in such a system, the extent of tree planting and the resultant benefits to the region will be considerable. Similarly, serious efforts should be made to increase the area of savannah woodland by management control, with the participation of local communities. This type of pilot scheme is being tried in Umm Belut village in Darfur.

It would be desirable to consider introducing mixed production systems in specific areas which may require some changes in land management. An integrated approach, based on the interaction of

forestry, agriculture and pastoralism, may turn out to be an effective alternative which could reduce overexploitation of forests and also increase agricultural and livestock yields.

Any forest land management plan in Ethiopia, Somalia and the Sudan must consider the people's fuelwood requirements. Fuelwood development plans should be based on more reliable data than are presently available, and on realistic production potential assumptions, future demand, institutional capabilities and the country's capacity for absorbing external assistance.

Data collection and management

At present, the institutional arrangements and capabilities for providing planners and policy makers with the information they require on various aspects of land use and farming systems are constrained by the lack of adequate, reasonably reliable data and also by the absence of appropriate data processing systems. Often, the full potential of any useful data cannot be realized because of delays in data processing and lack of published results. It is not unusual to find that some of the data which are of basic importance for planning decisions are only published several years after the period to which they refer. Accordingly, such information is of limited value for planning and decision making.

Two major problems have to be resolved before data collection and management problems can be overcome. These are:

- the lack of an adequate number of properly trained and experienced professional staff, together with the heavy load of mundane work which is imposed by internal administration and by the reporting requirements of a multitude of donor agencies;
- the absence of a current and readily accessible database with satisfactory data processing facilities.

To a certain extent, both these problems stem from severe shortages of financial resources. These factors have contributed to the development of a vicious circle whereby lack of resources reduces both the extent and the quality of the data which can be collected. Users gradually lose confidence in the databases available and start setting up their own data systems, and resources available to the central organization are reduced even further. These events may lead to the establishment of several independent data systems which are often supported by donor agencies. There is little coordination or consultation between these various data systems, and this contributes to unnecessary duplication, creation of incompatible systems and the production of inconsistent data. The continuity of some of these systems is doubtful, especially when they are set up under an aid project, upon completion of a project, and/or on departure of foreign advisors.

Until and unless the importance of the ready availability of reliable data in the area of land use and farming systems is recognized as an important factor by senior policy makers, it is unlikely that the present situation will change significantly in the future.

Manpower development and training

At present, national institutions are not properly established to develop a critical mass of good professional cadres specialized in land use and farming systems. While some universities, eg Khartoum, can produce professionals in certain aspects of land use such as irrigation engineer-

ing, their curricula have not so far taken into account the specific requirements of multifaceted and multidisciplinary subjects such as land use planning and policy making. Before educational institutions can embark on providing such courses, it will be necessary to consider the training of trainers. On a long-term basis, each country must develop its own educational establishments to train professionals on land use. Only then can it respond quickly to changing national requirements and priorities, training people and conducting research according to national needs. Overseas training is not only expensive, but also it may not properly reflect national requirements. Ideally, overseas training should be limited to those professional staff who have already had education and training at home, but who require specific skills for which training is not available locally. One reason why it is not available may be because the number of professionals to be trained in that area is so limited that it does not make sense economically to develop training facilities. If professionals are being sent for external training, measures should be taken to ensure that they actually return to work in their home country for a reasonable period of time, and that the tasks assigned to them on return are rewarding and commensurate with their training.

Training requirements on land use and farming systems at the various national institutions should be systematically identified, along with manpower requirements. Manpower development and training plans for professional and technical staff should form an integral component of all land use and educational sector plans. On-the-job training should be encouraged and staff selected for training should be screened with care.