

Table 10.13 Annual soil losses from a small catchment in the Lake Victoria basin

Land use	Land cover (%)	Range of soil loss (tonnes/ha/year)
Annual cropland	6	65–93
Rangeland	15	42–68
Bananas/Coffee	63	36–47
Bananas	6	22–32
Forest	1	0
Papyrus marsh	9	0

10.4 Sustainable management of hot arid and semi-arid environments

Sustainable management is management that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. It is a process by which human potential (quality of life) is improved and the environment (resource base) is used and managed to supply humanity on a long-term basis.

Nearly three-quarters of the world's drylands are degraded and it has been estimated that desertification costs an estimated \$42 million each year. Are there sustainable options for the world's drylands?

□ Changing land-use trends

Case Study: Game farming in the Eastern Cape province of South Africa

A shift from pastoralism to **game farming** has been identified in the Eastern Cape province of South Africa since the 1980s (Figure 10.21). Examples include Bushbuck Ridge Game Farm, AddoAfrigue Estate and Kichaka Lodge. In some cases, this change has been made by private landowners to diversify their operations. In other cases, private landowners have removed all stock and replaced it with game. In a survey of the Eastern Cape region of South Africa, it was found that 2.5 per cent of the study area had converted entirely from stock to game farming. A total of 41 game species was recorded on the 63 game farms surveyed. Most farmers expressed a positive attitude towards game farming and are trying to implement conservation measures. The main activity for which game is utilised is hunting – both recreational and trophy hunting. The foreign ecotourist and the hunting market have been strong driving forces behind the introduction of **extra-limital** (non-native) species to the region.



Figure 10.21 Location of the Eastern Cape province of South Africa

This change in land use has drawn the attention of scientists worldwide, and specifically with reference to desertification of rangelands. Desertification currently affects about one-sixth of the world's population and 70 per cent of all drylands, which amounts to 3.6 billion hectares. Widespread poverty is one of the key impacts of desertification.

In South Africa, the thicket vegetation of the Eastern Cape has been recognised as being particularly vulnerable to degradation, due mainly to years of overgrazing. Over 95 per cent of this vegetation is under threat from overgrazing by domestic stock; bush clearing for agriculture and urban development; coastal resort development; and invasion by alien vegetation.

The average game farm size is 4496 hectares. Most of the game farms are concentrated in the south and central regions of the Eastern Cape. Land-use changes first started to occur in the 1970s, and were characterised by two basic trends that included either the landowners themselves changing from being stock farmers to game farmers, or investors purchasing stock farms and financing their conversion to game farms.

Utilising game has provided an important secondary income to most mixed farmers. The impetus behind the growing game industry can be attributed to a number of socio-political, economic and ecological motivations. For example:

- Recently changed labour legislation stipulates increased wages for workers on farms. This has made landowners regard game farming as an alternative to stock farming, as it is considered to be potentially less labour-intensive than traditional stock farming.
- Increased stock theft, especially of small domestic stock, has rendered stock farming economically less viable.
- Vermin such as the jackal and caracal sometimes come from adjacent game farms' statutory reserves and this has resulted in increased stock losses.
- Decades of overgrazing has led to rangeland degradation, thereby reducing livestock production. By (re)introducing (indigenous) game species that are better adapted to their

natural environment, periodic droughts can be survived both economically and demographically.

- Game is considered to contribute, in the long term, to **veld** restoration (rather than its degradation).
- There is good potential for foreign exchange earnings from trophy hunting and tourism.

A total of 41 game species were recorded on the 63 farms surveyed. The high diversity that was recorded was not, however, found on any single farm. Rather, 11–15 species occurred on a third of the game farms, with only five game farmers maintaining more than 20 species.

Game farming has been described as a potential ecologically sustainable form of land use, but the introduction of extra-limital species may threaten this state. In order to guarantee tourist satisfaction, farmers have found it necessary to erect game-proof fences around their farms with the purpose of introducing 'hunting' or 'tourist' species, whether indigenous or extra-limital. Kudu and bushbuck, both indigenous to thick

vegetation, are among the most desired hunting species in the Eastern Cape. Promotion of these animals as hunting species may promote ecologically sound farming practices, without the introduction of extra-limital species.

There is also the ecological risk of allowing certain species to hybridise by keeping such species in the same fenced area. Some farmers in the survey had both blue and black wildebeest species on their property, and some had both Blesbok and Bontebok antelope; both pairs of species have the ability to hybridise.

Section 10.4 Activities

- 1 Define *sustainable development*.
- 2 To what extent is game farming a form of sustainable development? Justify your views.



Case Study: The establishment of drought-resistant fodder in the Eastern Cape

Pastureland in the Eastern Cape is especially fragile due to drought and overgrazing (Figures 10.22 and 10.23). In the former homelands Ciskei and Transkei, there are additional problems of population pressure and, sometimes, the absence of secure land-ownership policies. During periods of prolonged drought, levels of cattle, sheep and goats decrease significantly. However, trying to decrease herd size has proved unpopular and unsuccessful. An alternative is to produce drought-resistant **fodder crops** such as the American aloe and prickly pear, saltbrush and the indigenous gwanish.



Figure 10.22 Gully erosion due to overgrazing



Figure 10.23 Concentration of sheep at a waterhole – note the irrigation scheme in the background

The American aloe (Figure 10.24) has traditionally been used for fencing, for kraals (animal compounds) and for soil conservation, but has also been used as a fodder in times of drought. It has a number of advantages:

- It requires little moisture (annual rainfall in this region is around 450 mm).
- It is not attacked by any insects.
- Although low in protein, it raises milk production in cows.
- It can be used for soil conservation.
- After 10 years, it produces a pole that can be used for fencing or building.
- It can act as a windbreak.
- The juice of the aloe is used in the production of tequila.



Figure 10.24 American aloe

Saltbrush provides protein-rich fodder that is eaten by sheep and goats. Goats, in particular, thrive on saltbrush. It requires less than half the water need by other crops such as lucerne, and once established it requires no irrigation. It remains green throughout the year and therefore can provide all-year fodder. However, it is difficult to propagate and needs high-quality management.



The spineless cactus or prickly pear (Figure 10.25) features prominently in the agriculture of many countries, such as Mexico, Peru and Tunisia, where it is used as fodder and as a fruit crop for 2–3 months each year. This plant is becoming more widespread in the Eastern Cape. Two varieties are common: one, insect-resistant, is used as fodder in times of drought, while the other, which needs to be sprayed to reduce insect damage, yields high-quality fruit. The fruit is sold at prices comparable with apples and oranges. Pruning is needed annually. This provides up to 100 tonnes of fodder per hectare per year.



Figure 10.25 Prickly pear

In the former Ciskei region of the Eastern Cape, drought in the 1980s prompted the government to embark on a series of trials with prickly pear, saltbrush and American aloe in order to create more fodder. One of the main advantages of the prickly pear is its low water requirements. This makes it very suitable to the region where rainfall is low and unreliable. Although there are intensive irrigation schemes in the region, such as at Keiskammahoek, these are expensive and are inappropriate to the area and to the local people.

Although prickly pear is mainly used as a fodder and fruit crop, it is also used for the production of carminic acid for the cochineal dye industry and as a means of soil conservation. Nevertheless, prickly pear has been described by some development planners as a 'weed, the plant of the poor, a flag of misery ... inconsistent with progress'.

Section 10.4 Activities

- 1 Outline the advantages of the American aloe plant.
- 2 Comment on the advantages and disadvantages of using the prickly pear.

Case Study: Essential oils in the Eastern Cape

About 65 per cent of the world's production of essential oils is from LICs such as India, China, Brazil, Indonesia, Mexico, Egypt and Morocco. However, the USA is also a major producer of essential oils such as peppermint and other mints. The South African essential oils industry has only recently emerged in this area. Currently, the South African essential oils industry exports mainly to HICs in Europe (49 per cent), the USA (24 per cent) and Japan (4.5 per cent). The most significant essential oils produced by South Africa are eucalyptus, citrus, geranium and buchu.

Globally, the essential oils industry – valued at around \$10 billion – is enjoying huge expansion. Opportunities include increasing production of existing products and extending the range of crops grown. Developing the essential oils industry in South Africa would achieve much-needed agricultural and agri-processing diversification in the province.

Currently, the South African essential oils industry comprises about 100 small commercial producers, of which less than 20 per cent are regular producers.

Several factors make South Africa an attractive essential oils market:

- Much of the demand is in the northern hemisphere and seasonal effects make southern hemisphere suppliers globally attractive.
- South Africa traditionally has strong trade links with Europe, as a major importer of fragrance materials.
- South Africa is being established as a world-class agricultural producer in a wide range of products.

The Eastern Cape is set to become one of the main contributors to South Africa's burgeoning essential oils

industry, with 10 government-sponsored trial sites currently in development throughout the province. Six of these form part of the Essential Oil Project of Hogsback, where approximately 8 hectares of communal land are being used. A project at Keiskammahoek has been operational since 2006. These trials form part of a strategy to develop a number of essential oil clusters in the Eastern Cape.

The production of essential oils holds considerable potential as a form of sustainable agricultural development in the former Ciskei region of the Eastern Cape. Not only are the raw materials already here, but it is a labour-intensive industry and would employ a large number of currently unemployed and underemployed people.

The essential oils industry has a number of advantages:

- It is a new or additional source of income for many people.
- It is labour-intensive and local in nature.
- Many plants are already known and used by local people as medicines, and they are therefore culturally acceptable (Figure 10.26).
- In their natural state, the plants are not very palatable nor of great value and will not therefore be stolen.
- Many species are looked upon as weeds. Removing these regularly improves grazing potential as well as supplying raw materials for the essential oils industry.

Some species such as geranium, peppermint and sage require too much land, labour and water to be very successful. Wild als (*Artemisia afra*) is an indigenous mountain shrub, used for the treatment of colds. Its oil has a strong medicinal fragrance and is used in deodorants and soaps. Double

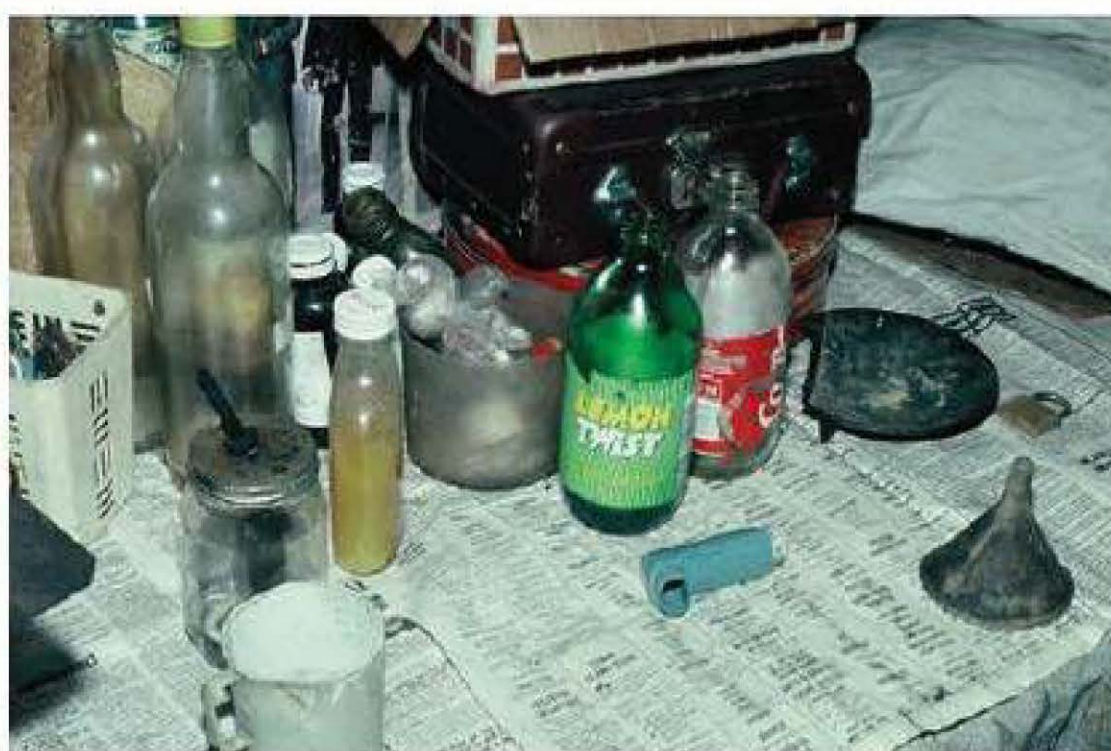


Figure 10.26 A herbalist's preparation table

cropping in summer when the plant is still growing and in autumn at the end of the growing season yields the best results. Demand for *Artemisia* has not outstripped the supply of naturally growing material but it is increasingly being cultivated as a second crop. It requires minimal input in terms of planting, tillage and pest control, and it is relatively easy to establish and

manage. Moreover, it can stabilise many of the maize fields and slopes where soil erosion is a problem. The local people are very enthusiastic about growing it, especially when they are given appropriate economic incentives.

Khakibush or *Tagetes* is an aromatic. In the former Ciskei area, it is a common weed in most maize fields. Oil of tagetes is an established essential oil, although its market is limited. Local people are again quite enthusiastic about collecting khakibush if the incentives are there. Harvesting takes place over a period of up to three months and provides a great deal of extra employment, as well as eradicating a weed. At present, the supply of khakibush and those in the maize fields is sufficient to meet demand. An increase in demand might lead to the establishment of *Tagetes* as secondary crop in maize fields – not just as a 'weed'.

Section 10.4 Activities

- 1 Suggest why the essential oils industry has developed in the Eastern Cape province.
- 2 To what extent could the essential oils industry be considered a form of sustainable development?

Case Study: Developing sustainable farming in Egypt

The Nile provides Egypt with almost all of its water, 85 per cent of which goes to agriculture – but population growth and increased demands for water is putting a strain on water resources. Up to 95 per cent of Egypt's population lives in the Nile Valley and Delta, increasing the pressure on land resources. The same area accounts for the bulk of Egyptian food production. Although one-third of Egypt's annual share of the Nile is used for irrigation, it contains pollutants and pesticides from upstream countries and from Egypt itself. Since chemical pesticides were first introduced to Egypt in the early 1950s, a million tonnes have been released into the environment. To compound the matter, Ethiopia is building the Grand Ethiopian Renaissance Dam on the Blue Nile, which is likely to cut supplies of fresh water to Egypt.

However, Egypt is developing forms of sustainable agriculture. One of the leading individuals is Faris Farrag, who has developed aquaponics at his farm outside Cairo called 'Bustan' (Arabic for orchard). Aquaponics is an integrated form of farming that originated in Central America. It enables farmers to increase yields by growing plants and farming fish in the same closed freshwater system.

Bustan is the first commercial aquaponics farm in Egypt. Water circulates from tanks containing fish through hydroponic trays that grow vegetables including cucumber, basil, lettuce, kale, peppers and tomatoes. Each tank contains about a thousand tilapia fish, which are native to Egypt and are known for resisting slight water pH and temperature variations. Water from the pond is then used to water the olive trees that produce a high-quality olive oil. This organic and closed system mimics natural processes and enables waste to be efficiently reused. The fish tanks provide 90 per cent of the nutrients plants need to grow. The ammonia that results from the fish breathing is naturally

transformed into nitrogen and absorbed by the plants before being sent back to the fish tanks, ammonia-free and healthy.

Just outside the fish tanks lies a large pond covered with a slimy layer of duckweed, a highly nutritious floating plant that is regularly scraped, dried and fed to the fish as vegetable protein.

Bustan uses 90 per cent less water than traditional farming methods in Egypt. It produces 6–8 tonnes of fish per year and can potentially yield 45 000 heads of lettuce if it were to grow just a single type of vegetable. Hydroponics can make lettuce grow 20 per cent faster than average.

Bustan is a labour-intensive farm and uses sustainable biological pest-control methods, such as ladybirds to kill aphids, in order to avoid chemical inputs. Farrag intends to establish a permaculture system by introducing chickens that would feed on compost and produce natural fertilisers for the soil.

This method of farming could serve as a means of income generation for unemployed women, as well as a means of education for sustainable farming. However, it is quite costly, especially for those on a low income. Inside Bustan, the pumps used to filter water require a source of energy, mainly oil. Farrag has invested more than \$43 500 to develop this scheme.

Small hydroponic units could be established for rooftops, balconies and kitchens. Vertical and rooftop farming, in light of the country's serious water and food crisis, is also an effective way to grow organic food while cutting transportation costs, emissions and waste.

Section 10.4 Activities

Research Bustan online and watch a video clip. Find out about fish farms in the desert and rooftop farms in Cairo.