

## Chapter 6

# Major soils for food production in Africa

The continent of Africa covers 30 million km<sup>2</sup> and straddles the sub-tropical and tropical belts from the Mediterranean (37°N) to the Cape of Good Hope (35°S). Its enormous size and variations in relief give a wide variety of climates, soils and agricultural systems. Nowhere in Africa is rainfall evenly distributed over the year; there are everywhere distinct wet and dry seasons. High insolation and high evaporation are about the only common factors.

The most important factor in assessing the potential agricultural use of the soil resources of Africa is climate, especially moisture regime.

By differentiating areas of varying moisture conditions in Africa, FAO (1979) and Dudal (1980) identified five major agro-ecological zones on the basis of the length of growing period defined in terms of the number of days when both moisture conditions and temperature permit rainfed crop production.

The zones identified are:

- Very humid to humid forest zone
- Humid to sub-humid wooded savannah zone
- Semi-humid wooded to semi-arid savannah zone
- Semi-arid to arid savannah zone
- Mediterranean zone.

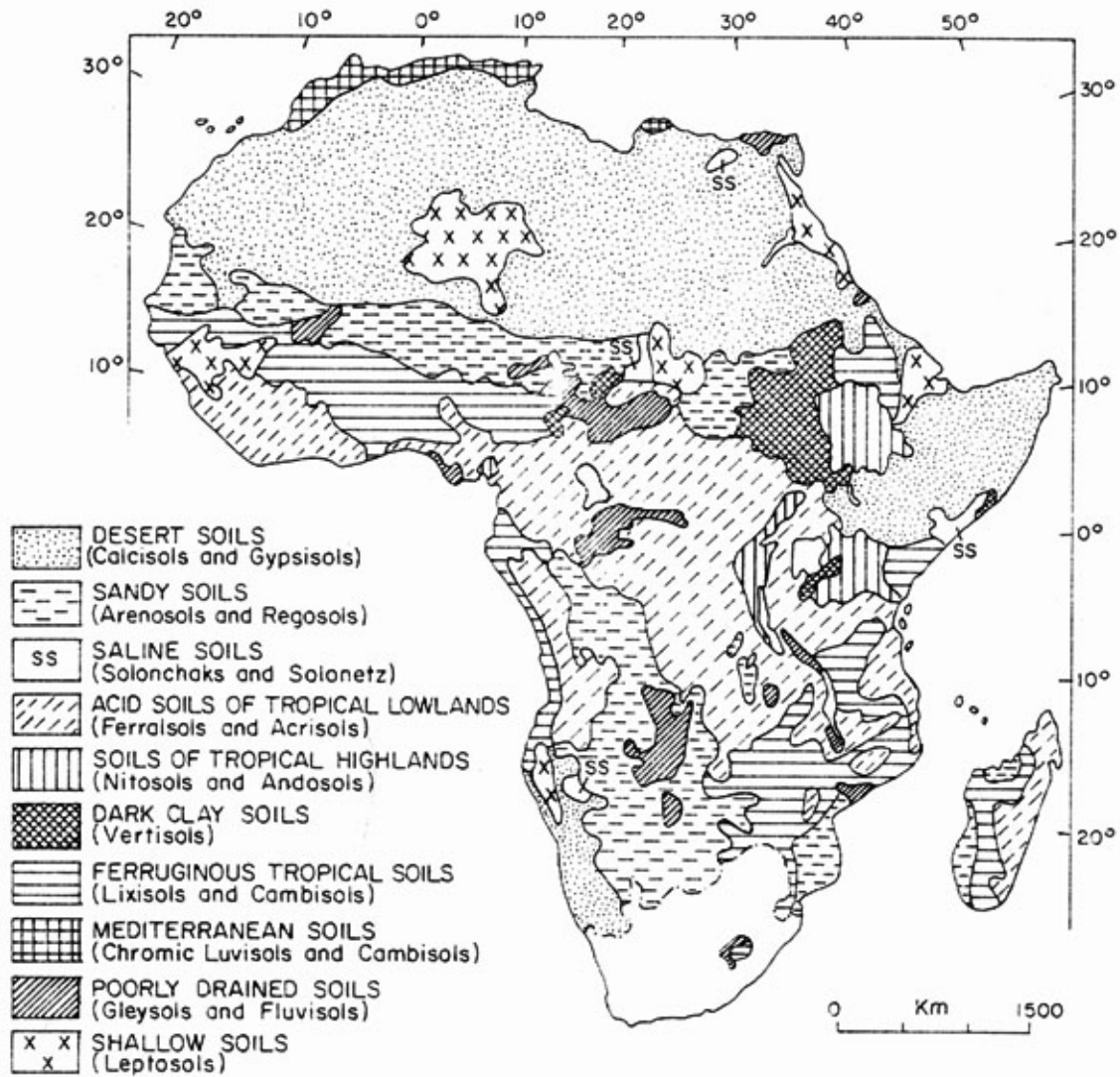
Using these zones as a basis, food production and the main soil types in Africa (Figure 31) are described below.

### **MAJOR SOILS GROUPS AND THEIR CONSTRAINTS ON FOOD PRODUCTION**

#### **Soils of the Very Humid to Humid Forest Zone**

This zone stretches from West to Central and East Africa where the rainfall exceeds a mean of 1500 mm a year, temperatures ranging between an average of 24-28°C with a growing period of more than 270 days.

**FIGURE 31**  
Main soil associations



It covers the extreme southeastern parts of Guinea and Guinea Bissau; almost the whole of Congo, Equatorial Guinea, Gabon, Liberia, Sierra Leone, Zaire and the islands of the Comoros, Madeira, Reunion, Sao Tome and Principe, Seychelles, Cameroon, Central African Republic, Chad, the southern parts of Côte d'Ivoire, Ghana, Nigeria, Swaziland and Tanzania; the northern parts of Angola, Burundi, Mozambique and Zambia; the western parts of Malawi and Rwanda; the highlands of Ethiopia and Kenya; the central parts of Benin, Mauritius, Togo and Uganda; and finally, the east coastline of Madagascar. In places, relief gives an increased rainfall. For example, Mount Cameroon rises 4070 m above the neighbouring warm sea and receives the full force of the humid air, thus giving the highest rainfall of the continent (averaging 10 000 mm annually at Debundja).

The major upland soils of this zone are Ferralsols, Nitosols, Acrisols, Arenosols, Cambisols, and Lithosols (FAO/Unesco 1977). Ferralsols, Nitosols, Acrisols and Arenosols are very extensively developed and for the most part deeply weathered and gravelly, mostly acid to very acid in reaction but with a considerable amount of organic matter built up under natural conditions due to abundant leaf-fall and rapid decomposition. Inherent fertility status is quite high in uncultivated soils, initially allowing extensive cultivation of a wide range of cash and food crops including cocoa, coffee, oil palm, rubber, coconuts, citrus, cassava, maize, plantain and cocoyam. After two to five cropping seasons, however, the nutrient levels are so reduced that farmers are obliged to abandon the cropped field for a newly cleared one. The result is that deforestation, which is already extensive, is still increasing due to population pressure. Other constraints which limit the ability of the deeply-weathered soils to produce high yields of climatically suitable crops are low cation-exchange capacity; weak retention of bases applied as fertilizers; fixation of phosphates; deficiencies of calcium, sulphur and trace elements; leaching during the rainy season; and moderate to high risk of erosion.

Cambisols are, however, more recently formed and are thus inherently more fertile. In many places within the zone, however, hilly relief and stoniness limit their development.

Lithosols, which are found in all the agroecological zones of Africa, are very shallow, occurring mainly on steep slopes often with exposed rock debris. These soils are at risk of very severe erosion.

The major lowland soils comprising mainly of Gleysols and Fluvisols (FAO/Unesco 1977) are generally deep, non-gravelly, and of medium to heavy texture, making them ideally suitable for extensive rice, sugarcane and vegetable production. They are subject to water-logging and flooding during the rainy season, so effective drainage control measures are needed to increase and sustain crop production.

Other lowland soils which are quite extensively developed within the zone are Regosols and Histosols. Regosols, mainly developed in mantles of recent sand deposits, occur extensively along the coastal area of the zone and are widely utilized for the cultivation of coconut palms. Extensive areas are also cultivated with cassava, pineapples and groundnuts.

Histosols (organic soils) occur extensively within large swampy areas located mainly on Côte d'Ivoire, Congo, Zaire, Zambia, Malawi and Madagascar. The main constraints making the soils unsuitable for agricultural production are permanent water-logging, low bearing capacity, weak anchorage for plants, subsidence upon drainage, frequent micro-nutrient deficiencies and irreversible shrinking of the organic material upon drying (Dudal 1980).

Within the humid zones of Africa, several cultural management practices have been described and suggested by various workers as being effective in arresting soil degradation. For example, surface mulching, which apart from its erosion-preventing effects, creates a favourable micro-environment for better crop yields.

Ridging has also been reported to cause significant reduction in soil losses by erosion. Experiments by Fournier (1967) in Cote d'Ivoire show that ridging decreases erosion compared with flat planting and that the less steep the slope, the greater the advantageous effect of ridging.

### **Soils of the Humid to Sub-humid Wooded Savannah Zone**

The humid to sub-humid wooded savannah zone covers areas between latitudes 5 to 15° North and 5 to 15° South in Central, Western and Southern Africa. Areas with one or two rainy seasons of varying lengths are located within this zone.

The zone embraces the whole of Southern Chad, The Gambia, Southern Mali and Mozambique; almost all of Ethiopia and Tanzania; the southern parts of Burkina Faso, Senegal and Sudan; the northern parts of Benin, Cameroon, Central African Republic, Côte d'Ivoire, Ghana, Guinea, Nigeria, Togo, Uganda and Zambia; the southwestern parts of Kenya, Madagascar, Swaziland and Togo; the middle parts of Lesotho; western parts of Malawi; the extreme western border tip of Burundi; the eastern parts of South Africa; the southeast coastal areas of Benin, Ghana and Togo; and finally, limited areas of western and southern Angola.

The major soils of this zone are generally found on level to very gently undulating land interspersed with low-lying hills (Inselbergs) and with a rainfall of 650 to 1400 mm annually under predominantly grassland vegetation. The soils are identified as Luvisols, Ferralsols, Arenosols, Acrisols, Nitosols, Cambisols and Lithosols. The upland soils are mostly well to moderately well drained, gravelly with a light-textured matrix which in some areas overlies an iron pan developed *in situ* at shallow depth.

The organic matter content and fertility status of the soils within the zone are, generally quite low compared with soils of the very humid to humid forest zone. These soils are used for the production of sorghum, maize, yam, millet and various leguminous crops including groundnuts, beans and cowpeas.

In higher country such as the East African highlands, the climate allows the cultivation of temperate cereals and other crops. Increased and sustained production, however, requires the application of fertilizers and the use of strict soil and water conservation measures.

The predominantly soil-related constraints which limit the ability of the major soils of the sub-humid wooded savannah zone to produce abundant crops are mainly moisture stress and sensitivity to erosion, particularly, under conditions of inadequate crop cover (Dudal 1980). Other restrictions are low cation exchange capacity, high base saturation, low phosphorus availability, micro-nutrient deficiencies, low aggregate stability and surface sealing under the effect of rains resulting in increased runoff; root-zone limitation due to surface layers of plinthite, ferruginous concretion and/or ironpan. Mulching and ridging are effective in controlling soil erosion.

The lowland soils within the zone include Fluvisols, Gleysols, Vertisols and are mostly non-gravelly with a reasonably moderate to high inherent fertility status, making them more productive than their upland counterparts. Crops which can be successfully grown on these soils are rice, sugarcane and vegetables. Where Vertisols and other lowland clayey soils are extensive, the main constraints are tillage difficulties, caused by stickiness when wet and hardness when dry, slow permeability, slow internal and external drainage, seasonal water-logging, flood risk and in certain cases, salinity and alkalinity. Other lowland soils include Plinthic Luvisols, Regosols and Histosols.

### **Soils of the Semi-humid Wooded to Semi-arid Savannah Zone**

This zone covers areas between the sub-humid wooded savannah zone and the arid zone between latitudes 15° and 20° north and 15° to 25° south where the average rainfall ranges from 200 to 800 mm. It embraces the whole of Botswana, parts of Kenya, South Africa and Zimbabwe; the southern parts of Mauritania, Mozambique, Niger, Somalia and Zambia; the eastern parts of Ethiopia and Swaziland; the northern parts of Burkina Faso, Morocco, Namibia and Senegal; the central parts of Chad, Mali, Sudan and Tunisia; the extreme northern corners of Cameroon and Nigeria and limited western areas of Angola.

The major upland soils are generally found on level to near-level topography with isolated low-lying hills (Inselbergs) with mainly short grass savannah grading into a desert-like type of vegetation. Such soils are of high clay activity and mostly referred to in the FAO/Unesco (1977) Legend as Xerosols, Luvisols, Cambisols, Arenosols, Rendzinas and Lithosols.

Xerosols occur extensively around the edges of the Sahara and the Kalahari deserts and in East Africa. They are for the most part shallow and difficult to use for crop production because of their extreme droughts and the stony and/or petrocalcic nature of the terrain. With the aid of irrigation, the deeper, medium-textured soils and associated alluvial soils can be used for the cultivation of cereals, especially within the South African Karroo. The best land use for such soils within the semi-arid parts of the zone, is extensive livestock-raising which, if possible, should be managed in order to avoid degradation.

In northern Nigeria, Swaziland, Zambia and Zimbabwe, Luvisols are extensively used for groundnuts, sorghum, maize and tobacco production.

The major lowland soils which occur within the semi-arid zone are Fluvisols, Gleysols, Regosols, Planosols, Vertisols, Solonetz and Solonchaks.

Planosols and the sodic and saline soils of Solonetz and Solonchaks are very difficult to develop agriculturally. They easily become waterlogged and are often flooded. With proper drainage and flood control measures, rice can be grown during the rainy season. Solonetz soils are extensively used for livestock-raising and in Chad, where they are only slightly sodic, they are used to grow wheat, millet and maize. Solonchaks are, generally, undeveloped for agricultural production, as salinity renders them unfit for any type of cultivation. In Algeria, however, where furrow irrigation is employed to leach out the salts, cotton is being grown successfully on a large scale.

The most important constraint which limits the ability of the soils of the zone to produce high yields of crops is moisture stress. Other restrictions include low fertility, salinity and alkalinity, deficiencies of iron and zinc, as well as the constraints listed above for similar groups occurring in the sub-humid wooded savannah zone.

## **Soils of the Semi-arid to Arid Savannah Zone**

The arid savannah zone of Africa covers extensive areas north of latitude 20°N and south of 20°S where the average annual rainfall is less than 200 mm. The zone includes the vast Sahara desert and the Namibia, Kalahari and Karroo deserts. It covers almost the whole of Libya, Somalia and Algeria; the northern parts of Chad, Mauritania, Niger, Egypt, Mali and the Sudan; the southern parts of Morocco, Tunisia and Botswana; the western areas of South Africa, Namibia and Angola; and, finally, the extreme northern and eastern parts of Kenya.

The major soils of the zone are Yermosols, Xerosols, Lithosols, Regosols, Solonetz and Solonchaks. Such soils are mainly sandy, rocky and calcareous or siliceous, with salt and gypsum deposits occurring extensively. They are, generally, very low in inherent fertility and devoid of moisture and vegetation throughout the year. They are very susceptible to wind erosion.

Traditionally, land use within the arid zone of Africa is predominantly nomadic livestock grazing.

The major constraints within the zone affecting the survival of man, animals and plants are adverse climatic conditions associated with rocky, stony and sandy soils with extremely low inherent fertility.

## **Soils of the Mediterranean Zone**

This zone embraces the extreme northern and southern parts of Africa, especially the coastal areas of Algeria, Egypt, Libya, Morocco and Tunisia. Climatic conditions are quite different from tropical Africa. The main soils are, however, similar to those of the sub-humid wooded savannah, the semi-arid savannah and the arid savannah zones. These are Rendzinas, Phaeozems, Cambisols, Kastanozems, Arenosols and Solonchaks.

Rendzinas are very limited in Africa, occurring mainly within the semi-arid and Mediterranean zones. They are endowed with essential nutrients and have high humus content, but, generally, occur in hilly or moderately sloping areas. Their wide use for increased and sustained crop and livestock production is limited by topography. The development of intensive irrigated agriculture is only possible locally where the topography is favourable. Within the Mediterranean zone, hilly areas are used to grow olives, figs and vines, with moderate sloping areas reserved for the production of wheat and barley.

Phaeozems are also limited in distribution in Africa. They are excellent soils for both traditional and modern farming since they have practically no soil limitations. Seasonal drought may, however, limit their ability to produce high yields. For maximum production of crops and pasture, irrigation is needed during the dry season.

Kastanozems, which have been mapped in Morocco and Tunisia, generally occur over undulating terrain in association with Cambisols, Fluvisols or Vertisols. They are, like Rendzinas, endowed with essential nutrients and have high humus content. They are mainly devoted to the cultivation of wheat, barley, olives, figs and vines as well as the extensive grazing of livestock. With appropriate irrigation, they are capable of producing large yields of a wide variety of climatically-suited fruits as well as cotton and vegetables.

On the whole, soil-related constraints within the Mediterranean zone are similar to those of the semi-arid and arid zones and as such, will require similar ameliorative measures.

## CONCLUSIONS

Africa has an extremely wide range of soils and climatic conditions. The soils range from stony shallow ones with meagre life-sustaining capabilities to deeply weathered profiles which recycle and support a large biomass.

In many parts of Africa, inappropriate land use, poor management and lack of inputs have led to a decline in productivity, soil erosion, salinization and loss of vegetation. African soils are widely at risk, they are commonly undergoing severe degradation since the traditional methods used by indigenous farmers (shifting cultivation, nomadic grazing) cannot now cope with the increasing needs of the ever-expanding human and livestock populations.

Conservation action to halt and reverse degradation needs to be planned in detail for each land type and socio-economic circumstance. However, the following practices are generally beneficial:

- halting and reversing arable land degradation by finding economic solutions to soil fertility depletion, improving soil moisture conditions and combating soil erosion;
- arresting and reversing grazing land degradation by improving grazing livestock production systems, controlling livestock populations and integrating crop and livestock production;
- arresting forest degradation by planning firewood and timber supplies and ensuring adequate forest regeneration.