of breeding programmes are to produce cocoa varieties that are early bearing, resistant to pests and diseases, drought tolerant, higher yielding and sometimes with better flavour or other quality attributes.

The type of planting material originally introduced into an area has strongly influenced the type of cocoa grown today and hence the quality and uses of the cocoa beans (see Section 2.7).

2.2.3 Climatic and environmental requirements

Cocoa grows in areas of high rainfall, preferably 1500–2500 mm (60–100 in), evenly distributed throughout the year. If there is a dry season of more than three months, some form of irrigation may be necessary. Cocoa prefers high humidity, typically 70–80% during the day and up to 100% at night. Strong dry winds can defoliate the tree and very strong winds or hurricanes can cause physical damage.

The temperature requirements are a mean monthly minimum of 18 °C (64 °F) and a mean monthly maximum of 32 °C (90 °F). The absolute minimum is about 10 °C (50 °F).

Quite a wide range of soil is suitable for cocoa, but it grows best where the soil is deep, with good drainage and a pH of neutral to slightly acidic. Soil influences one important quality aspect of cocoa: the cadmium content. Some soils, especially volcanic ones, can contain high levels of cadmium. If this is in an "available" form, it may be taken up by the plant and become present in the beans (see Section 2.6.4).

2.2.4 Propagation of the planting material

The most common method of propagation is by seed. Good planting material may be obtained from selected parents by using hand pollination. These hybrids may also have hybrid vigour, giving faster growth and earlier bearing. Growing cocoa from seed produces a tree with a straight, single, vertical trunk with branches at around 2 m (6.5 ft) above the ground. This point, where the trunk separates into branches, is called the jorquette. Trees grown from seed tend to be more drought tolerant and require less pruning. However, they often exhibit a great deal of variability in their agronomic characteristics which is not desirable. This can be overcome by using one of the techniques of vegetative propagation such as cuttings, grafting or micropropagation systems. Grafting can be onto young seedlings, small plants or even mature trees. Grafted trees tend to have a more open branching structure, usually without the straight single trunk associated with seedling (hybrid) cocoa.

Micropropagation systems are under development: one system involves culturing some cells and growing them into plantlets, which are then transferred to a nursery. Micropropagation enables more rapid propagation of new varieties developed by plant breeders. The trees have a similar structure to seedling-grown trees. All the vegetative methods produce trees that are identical genetically to the original tree and therefore perform similarly in respect to yield, disease

resistance and quality parameters. The plants are initially grown in a nursery and, after 3–6 months, they will be ready to plant out in the field.

2.2.5 Establishment and development of the plants in the field

The selection of a suitable site is very important and needs to take into account local factors, such as weather conditions (especially rainfall, temperature and wind), soil fertility and drainage. Prior to planting, the site is prepared, which normally involves some land clearance and establishing some form of shade (unless it is already present). Shade protects the trees from excessive sunlight and wind. Initially shade requirements are high for young cocoa trees and it is common practice to plant a temporary shade of bananas or plantains (see Figure 2.4).

Cocoa trees are usually planted to achieve a final density of 600–1200 trees/ha (1500–3000 trees/acre). In the first year, the cocoa is often inter-cropped with food crops. Trees come into bearing when they are 2–3 years old and full yield is achieved after 6–7 years. They have an economic life of 25–30 years or more, provided they are consistently looked after with good agricultural practices. Maintenance of the tree is mainly pruning (to keep to a canopy height of 3–5 m (10.0–16.5 ft)) and weed control. Depending on the soils, natural or approved chemical fertiliser may be applied to correct deficiencies and so increase yields, although this is unusual on small holdings.

Figure 2.4 Young cocoa grown under banana shade. Reproduced with permission of Remo Nägeli.