fine, sandy as coarse, while silt is an intermediate (**Fig. 6.1**). The standard unit for the measurement of soil particles is the millimetre, but a smaller unit is the micron (1 micron = 0.001 mm), which is applicable, for instance, to the measurement of soil colloids. In sandy soil, the size of individual grains varies between 0.05 and 0.2 mm which are visible to the naked eye. The individual grains of clayey soil are 0.002 mm in diameter. Silty soil is finer than sand but coarser than clay. Its particles are found to have a diameter between 0.02 and 0.002 mm.

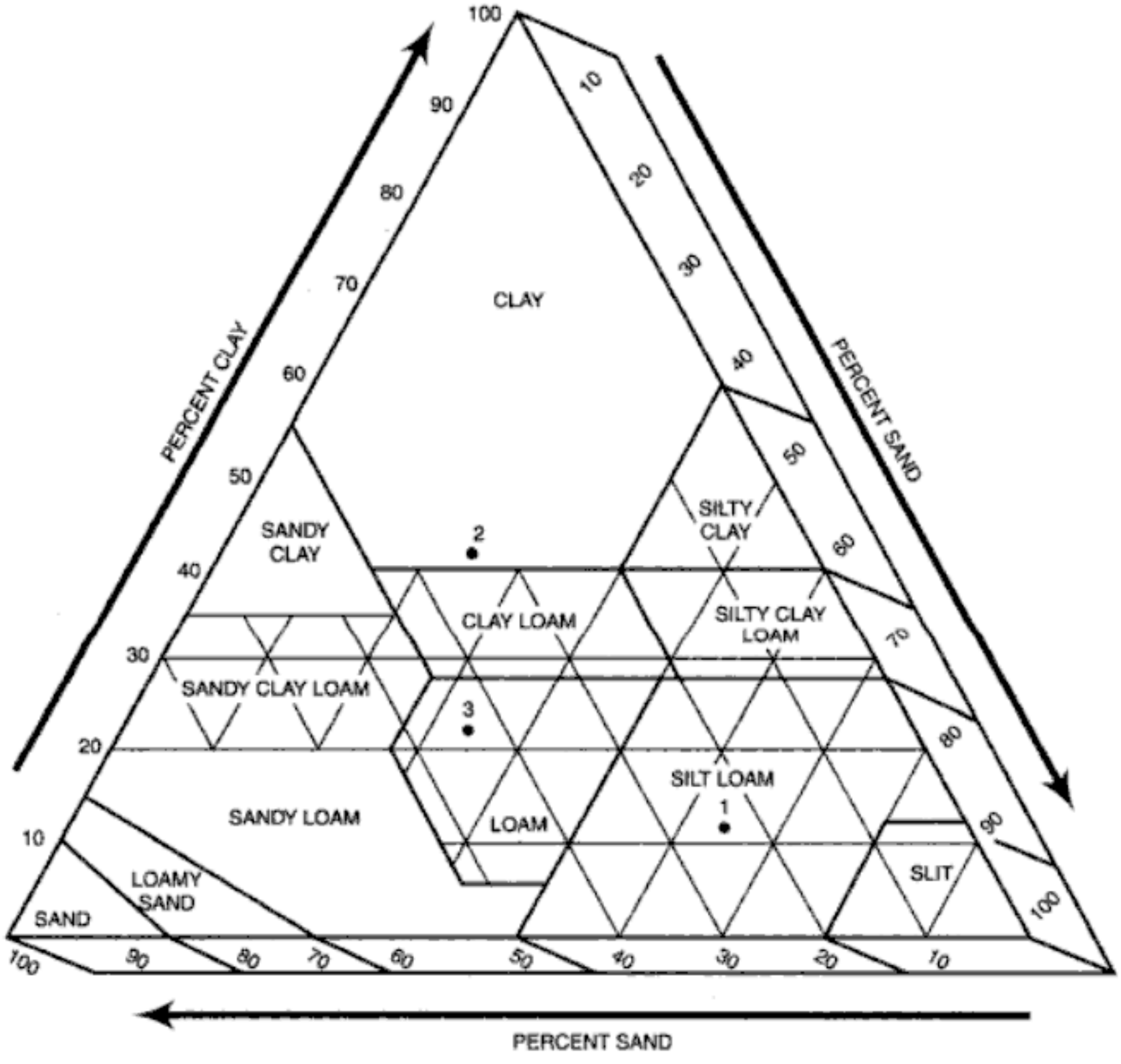

Fig. 6.1 Soil Texture Triangle

Soil Structure

Soil structure refers to the arrangement of soil particles. The way in which sand, silt, clay, and humus bond together to form beds is known as soil structure.

Soil Acidity

The acidity and alkalinity of soils is expressed in the pH value, which is a scale that measures the concentration of hydrogen ion held by the soil colloids (particles). In pure water, one part in 10 million is dissociated to form hydrogen ions, i.e., 10^{-7}, and the pH is thus 7; this is a neutral state

Developed on Archaean granite, these soils are also known as the omnibus group. Their colour is mainly red because of the presence of ferric oxides. Generally, the top layer is red, while the horizon below is yellowish in colour. The texture of red soils varies from sand to clay and loam. Their other characteristics include porous and friable structure, absence of lime, *kankar* and carbonates and small quantity of soluble salts. In general, these soils are deficient in lime, phosphate, magnesia, nitrogen, humus, and potash. Intense leaching is a menace to these soils. In the uplands, they are thin, poor, gravelly, sandy, or stony and porous, light-coloured soils, but in the lower plains and valleys, they are rich, deep, dark coloured fertile loams. In places where irrigation water is available, they are devoted to wheat, cotton, pulses, tobacco, millets, oilseeds (linseed), potato, and orchards.

3. Black or *Regur* Soils

Black soils, also known as *Regur* (cotton-soil) and internationally as 'tropical chernozems', are the third largest soil group in India. They sprawl over about 50 million hectares accounting for 15 per cent of the total reporting area of the country. Getting their parent material from the weathered rocks of Cretaceous lava, they stretch over the greater parts of Gujarat, Maharashtra, western Madhya Pradesh, north-western Andhra Pradesh, Karnataka, Tamil Nadu, Rajasthan, Chhattisgarh, and Jharkhand, up to Rajmahal Hills. They are mature soils. Over the greater parts of the black earth soil, the average annual rainfall varies between 50 and 75 cm.

The colour of these soils varies from deep black to light black. In general, these soils have clayey texture and are rich in iron, lime, calcium, potash, aluminium and magnesium. They are, however, deficient in nitrogen, phosphorous and organic matter. Moreover, these soils have a high water retaining capacity. They are extremely compact and tenacious when wet, and develop wide cracks when dry. In other words, they swell greatly and become sticky when wet in rainy season. When the soil is wet, it becomes difficult to plough the field as the plough gets stuck in mud. In the dry season, the moisture evaporates, the soil shrinks and develops wide cracks, often 10-15 cm deep. These soils are highly productive, and thus well suited for the cultivation of cotton, pulses, millets, linseed, castor, tobacco, sugarcane, vegetables, and citrus fruits.

4. Desert Soils

Sprawling over about 15 million hectares, the desert soils account for over 4.42 per cent of the total reporting area of the country. These soils are developed under the arid and semi-arid conditions and deposited mainly by wind action. They are found mainly in Rajasthan, west of the Aravallis, northen Gujarat, Saurashtra, Kachchh, western parts of Haryana, and the south-western parts of Punjab.

The desert soils are sandy to gravelly with low organic matter, low nitrogen and varying percentage of calcium carbonate. These soils contain high percentage of soluble salts, but have low moisture content and low water retaining capacity. If irrigated, they give high agricultural returns. The availability of water from the Indira-Gandhi Canal has transformed the agricultural landscape of the desert soils of western Rajasthan. These soils are mainly devoted to *bajra*, pulses, *guar*, fodder, and less water requiring crops.

of gully erosion is provided in the Chambal valley in Madhya Pradesh. Rajasthan, and Uttar Pradesh also provide typical examples of gully erosion. (**Fig. 6.6**). Gully erosion is also significant in the Shiwalik tracts of Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir, Uttarakhand, Uttar Pradesh and along the southern slopes of Himalayas, and the Western and Eastern Ghats.

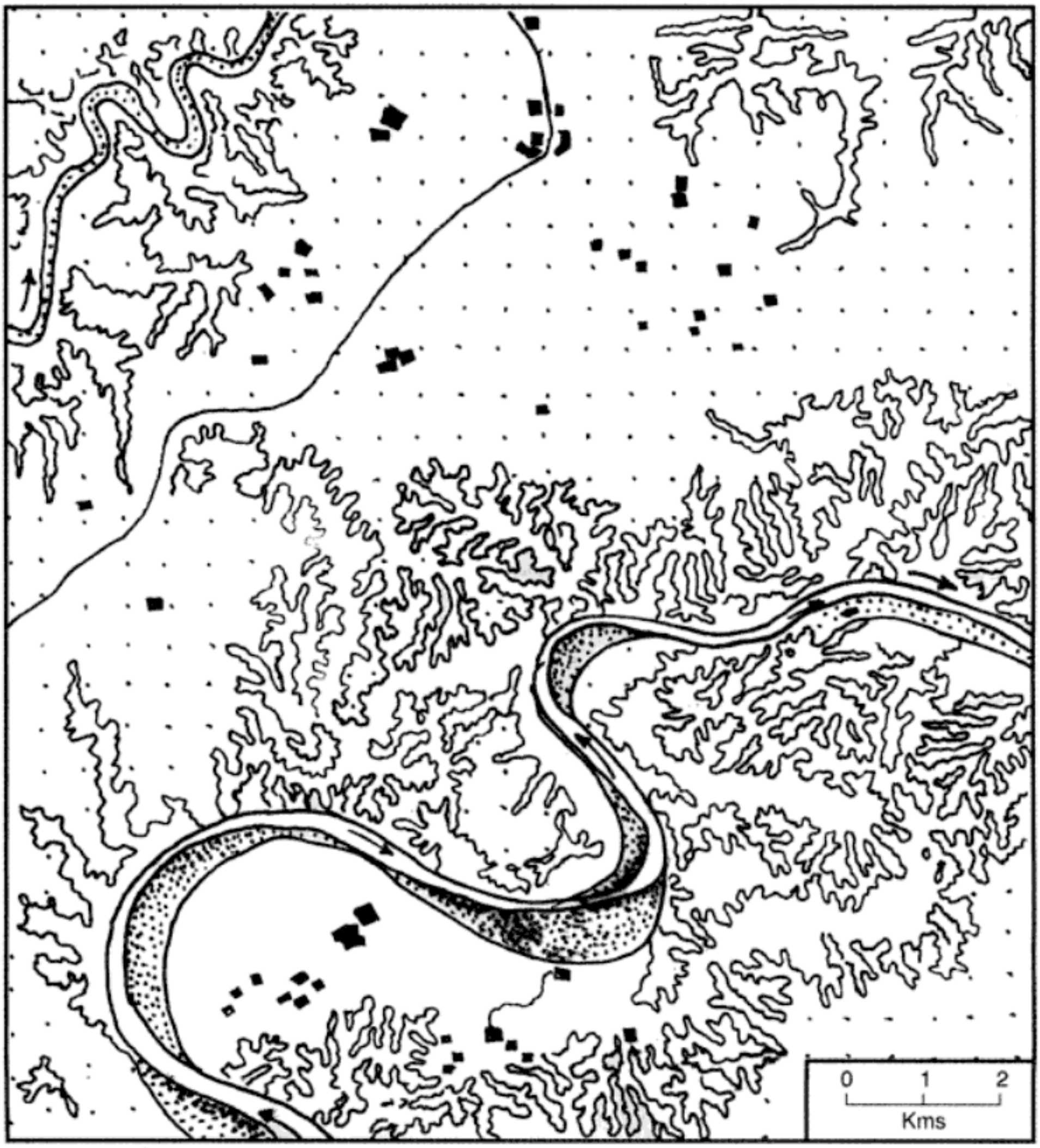

Fig. 6.6 Gully Erosion in Chambal Valley

(i) Loss of fertile top soil from the top layer leading to gradual loss of soil-fertility and agricultural productivity.
(ii) Loss of important nutrients from soil through leaching and water-logging.
(iii) Lowering of the underground water-table and decrease in soil moisture.
(iv) Drying of vegetation and extension of arid lands.
(v) Increase in the frequency of droughts and floods.
(vi) Silting of rivers and canal beds.
(vii) Recurrence of land slides.
(viii) Adverse effect on economy which retards cultural development.
(ix) Increase in crimes and anti-social activities through the formation of natural hideouts for criminals and dacoits.
(x) Burden on the exchequer to reclaim the bad lands.

There is no uniform strategy to reclaim all the wasteland and degraded soils of different types. Some strategies that might help are given below:

(i) All the degraded forest lands should be planted with trees. Marginal lands which are not suitable for agriculture should be brought under social forestry and agro-forestry.
(ii) Degraded soils and degraded lands can be reclaimed with the help of watershed programmes.
(iii) Rainwater harvesting and conservation should be the focus of development planning. A series of small projects of water harvesting in the watershed areas should be undertaken to maximise benefits from watershed projects.
(iv) Soil conservation practices should be adopted which have been briefly described in the following pages.

SOIL CONSERVATION

Looking at the importance of soil resources for a country of over a billion people, a judicious utilisation and conservation of soil is of parmount importance.

The farmers in the drier parts of Gujarat, Haryana, Rajasthan, and western Madhya Pradesh have successfully protected their fields from soil erosion by planting rows of trees to reduce the velocity of winds which continually erode soil cover. Soil conservation includes reduction in soil erosion, afforestation, rational utilisation of soils and ways to enhance their sustainability. Some of the important steps which can go a long way in the conservation of soils are as under:

1. Afforestation

Tree plantation helps in the reduction of soil erosion. Trees reduce the intensity of runoff and increase the seepage of water to the underground water-table. Social forestry can be developed along the banks of rivers, canals, lakes, roads, and railway tracks.

2. Restriction on the Felling of Trees

Apart from afforestation, it is equally important to check the indiscriminate felling of trees. People's awareness that resulted in the launch of the *Chipko Movement* can help in achieving this objective.

3. Contour Ploughing and Strip Cultivation

In the hilly and mountainous areas, ploughing should be done according to the contours and not