2 DRAINAGE OF AGRICULTURAL LANDS

2.1 Need for Drainage

Agriculture needs water, either from rainfall (9) or from irrigation (1 & 2). When irrigation or drainage is introduced in an area it affects the water balance. As it may be seen in Figure 1, to apply irrigation water to a crop, water has to be diverted from a river or lake (1) or from the groundwater reservoir (2). The amount of water diverted has to be greater that the quantity required by the crops because the diverted water will leave the area not only as evapotranspiration by the irrigated crop (3), but also as evaporation (4), seepage (5) and operational spills (6) from the irrigation canal system, as tailwater runoff from irrigated fields (7), and as deep percolation (8). In the field, irrigation water together with any rainfall (9), will be partly stored on the soil surface (10) and partly infiltrate in the soil (11). When rain or irrigation continues, pools may form on the soil surface, and this excess water needs to be removed. This standing water on the soil surface is called ponding water.

Ponding is the accumulation of excess water on the soil surface

Part of the water that infiltrates the soil will be stored in the pores and used by the crop (3) and part of the water will be lost as deep percolation (8). When the percolating water reaches that part of the soil which is saturated with water, the watertable will rise (12). If the watertable reaches the root zone, the plants may suffer (Figure 2). The soil has become waterlogged.

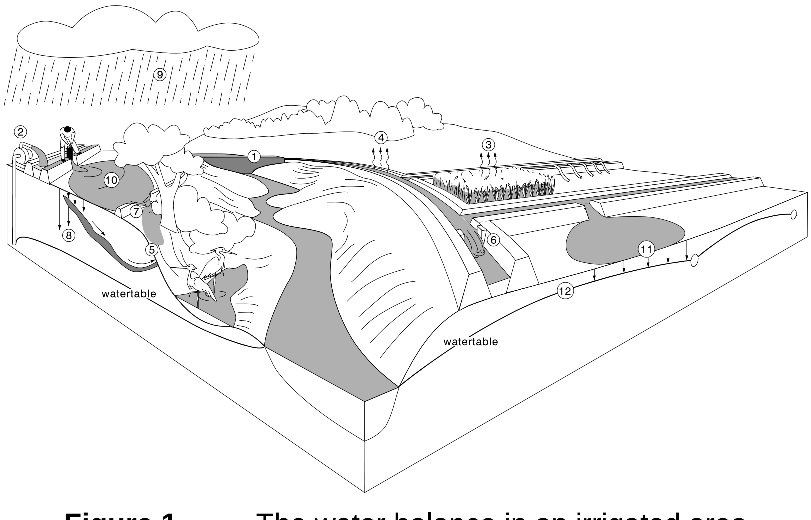

Figure 1 The water balance in an irrigated area

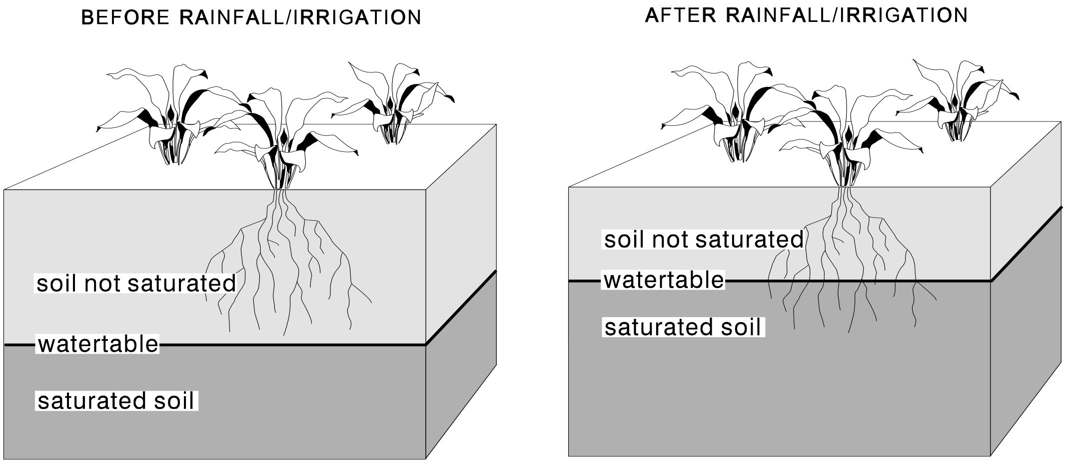

Figure 2 After irrigation or rainfall the water table may rise and reach the root zone

Waterlogging is the accumulation of excess water in the root zone of the soil.

Drainage is needed to remove the excess water and to control the rise of the watertable. Even in irrigation water of very good quality there are salts, thus bringing irrigation water to a field means also bringing salts to the same field. The irrigation water is used by the crop or evaporates directly from the soil. The salts, however, are left behind (Figure 3). This process is called salinisation.

Salinisation is the accumulation of soluble salts at the surface, or at some point below the surface of the soil profile, to levels at which they have negative effects on plant growth and/or soils.

If these salts accumulate in the soil, they will hamper crop production. Some crops are more tolerant to salts than others. The highly tolerant crops can withstand a salt concentration of the root zone up to 10 dS/m, the moderately tolerant crops up to 5 dS/m and the sensitive crops up to 2.5 dS/m. To grow more sensitive crops, drainage is needed to remove these salts. Thus drainage is used to control ponding at the surface, to control waterlogging in the soil and to avoid salinisation, and may be defined as:

Drainage is the removal of excess surface and subsurface water from the land to enhance crop growth, including the removal of dissolved salts from the soil.

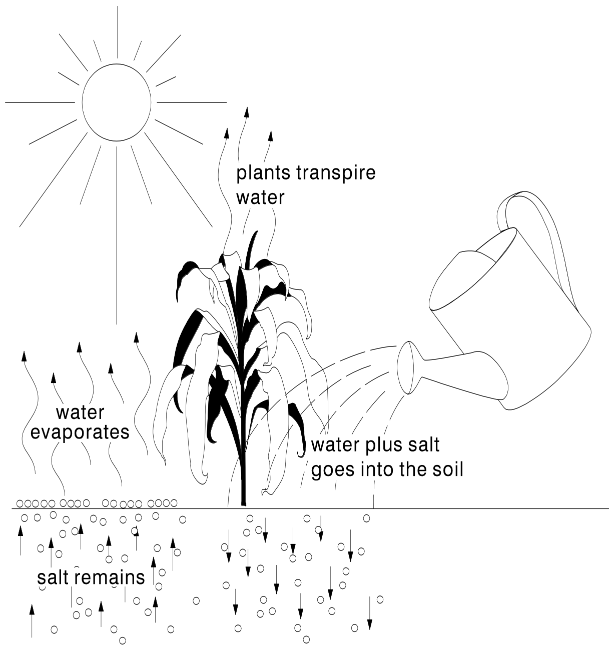

Figure 3 Irrigation water brings salts into the soil

Drainage is necessary for successful irrigated agriculture because it controls ponding, waterlogging and/or salinity. Drainage can be either natural or artificial. Most areas have some natural drainage; this means that excess water flows from the farmer's fields to swamps or to lakes and rivers. However, the natural drainage is often inadequate to remove the extra water or salts brought in by irrigation and in such a case an artificial or man-made drainage system is required.

A drainage system is an artificial system of land forming, surface and/or subsurface drains, related structures, and pumps (if any), by which excess water is removed from an area.

2.2 Drainage to Control Water Ponding

To remove excess (ponding) water from the surface of the land we use surface drainage. This is normally accomplished by shallow open field drains. In order to facilitate the flow of excess water towards these open drains, the field is usually given an artificial slope by means of land shaping or grading (Figure 4).

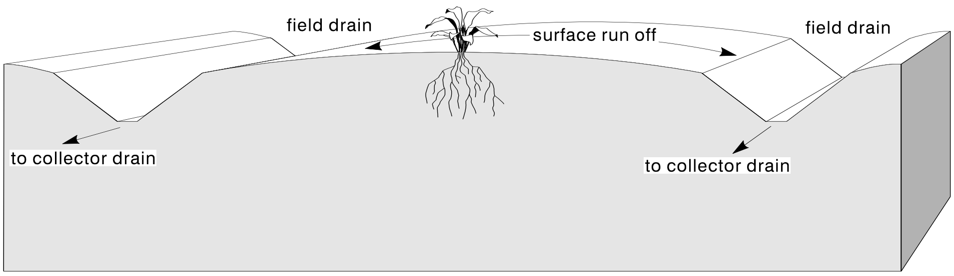

Figure 4 Surface drainage to remove excess water from the land surface

Surface drainage is the diversion or orderly removal of excess water from the surface of the land by means of improved natural or constructed drains, supplemented when necessary by the shaping and grading of land surfaces to such drains.

2.3 Drainage to Control Waterlogging

To remove excess water from the root zone we use subsurface drainage (Figure 5). By subsurface drainage we control the watertable, and excess water is removed from the underground by gravity through open or pipe drains installed at depths varying from 1 to 3 m.

Subsurface drainage is the removal of excess water and dissolved salts from soils via groundwater flow to the drains, so that the watertable and root zone salinity are controlled.

Tubewell drainage is a special type of subsurface drainage where excess water is removed by pumping from a series of wells drilled into the ground to a depth of several tens of metres. The pumped water is then discharged into open surface drains.

Tubewell drainage is the control of an existing or potential high watertable, or of artesian groundwater, through a group of adequately-spaced wells.

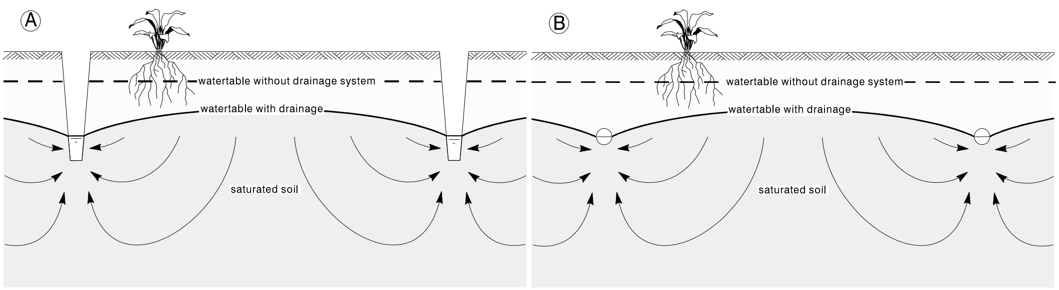

Figure 5 Field drains for surface drainage may be open (A) or pipe (B)

2.4 Drainage to Control Salinisation

To remove salts from the soil, water is used as a vehicle: more irrigation water is applied to the field than is required for crop growth. This additional water infiltrates into the soil and percolates through the root zone. During percolation the water takes up part of the salts from the soil and removes these through the subsurface drains (Figure 6). This process, in which the water washes the salts out of the root zone, is called leaching.

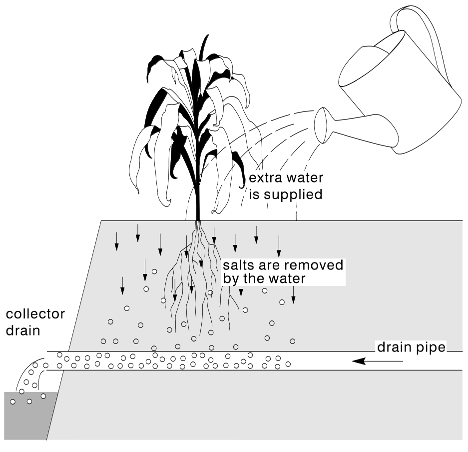

Figure 6 Extra irrigation water is applied to remove salts from the rootzone

Leaching is the removal of soluble salts by the passage of water through soil.

The additional water required for leaching must be removed from the root zone by means of drainage, otherwise the watertable will rise and this will bring the salts back into the root zone. Thus salinity control is achieved by a combination of irrigation and drainage measures. The different types of drainage systems, which can be used for the control of the watertable and/or the soil salinity, are discussed in Chapter 3.

Example:

Agriculture in the Nile Delta in Egypt depends almost entirely on irrigation from the River Nile. The total amount of irrigation water applied to the crops is about 1200 mm/year. Although this irrigation water is of good quality (0.3 dS/m) it brings a lot of salts into the soils:

- *Total volume of irrigation water :*
    - $V_i = 1200 \text{ mm/year} = 1200 \times 10^{-3} \times 10^4 \text{ m}^3\text{/ha/year} = 12 \times 10^3 \text{ m}^3\text{/ha/year}$
- *Salinity of irrigation water:*
    - $EC_i = 0.3 \text{ dS/m} = 0.3 \times 640 \text{ mg/l} = 200 \text{ mg/l} = 2 \times 10^{-4} \text{ ton/m}^3$
- *Total salts brought into the soil:*
    - $S = V_i \times EC_i = 12 \times 10^3 \text{ m}^3\text{/ha/year} \times 2 \times 10^{-4} \text{ ton/m}^3 = 2.4 \text{ ton/ha/year}$

Thus every year about 2.4 tons of salts are added to the soil profile and leaching is required to maintain a favorable salt balance.