Chapter 2

2.0 Drainage and crop production

2.1 THE NEED FOR DRAINAGE

When irrigation 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, it has to be diverted from a river or lake (1) or pumped from the groundwater reservoir (2). The amount of water needed has to be greater than the quantity required by the crop because some of it will leave the area in various ways: not only will it be used by the crop as evapotranspiration (3), but some of it will be lost as evaporation (4), as seepage (5) and operational spills (6) from the irrigation canal system, as tail water 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 will partly infiltrate into the soil (11). If rain or irrigation continues for long periods, pools may form on the soil surface. This accumulation of excess water on the soil surface is called **ponded** water. It needs to be removed.

Part of the water that infiltrates into the soil will be stored in the soil pores and will be used by the crop (3); another 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, it will cause the water table to rise (12). If the water table reaches the root zone, the plants may suffer. The soil has become waterlogged. Drainage is needed to remove the excess water and stop the rise of the water table.

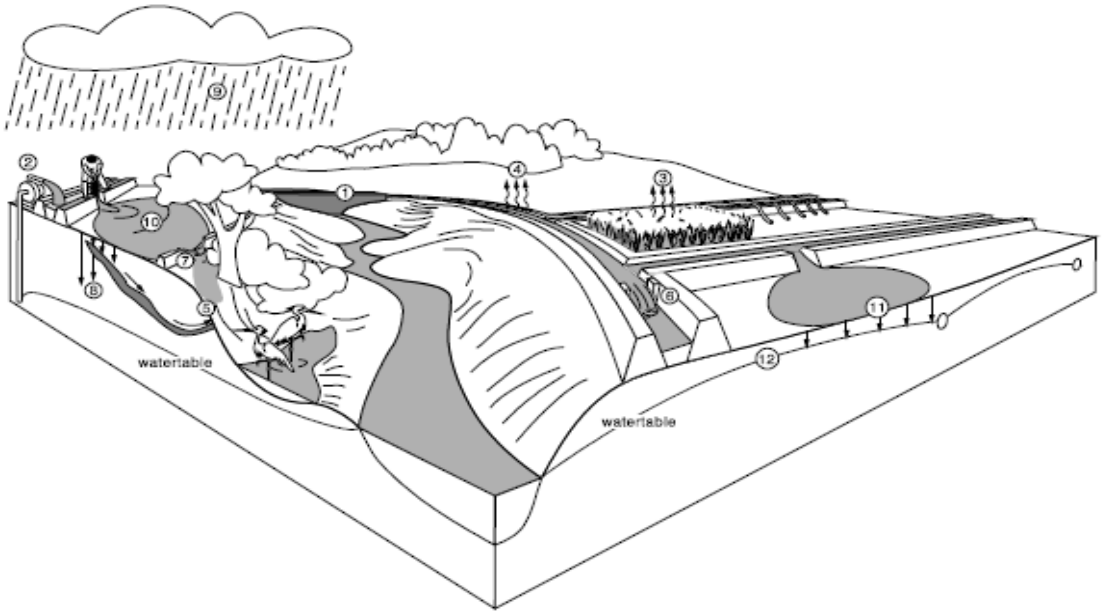

Fig 2.1 the water balance in irrigated area

Water logging is the accumulation of excess water in the root zone of the soil. Even if irrigation water is of very good quality, it will contain some salts. So, bringing irrigation water to a field also means bringing salts to that field. The irrigation water is used by the crop or evaporates directly from the soil. The salts, however, are left behind (Figure 2.3). This process is called **salinization.** If these salts accumulate in the soil, they will hamper the growth of crops.

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

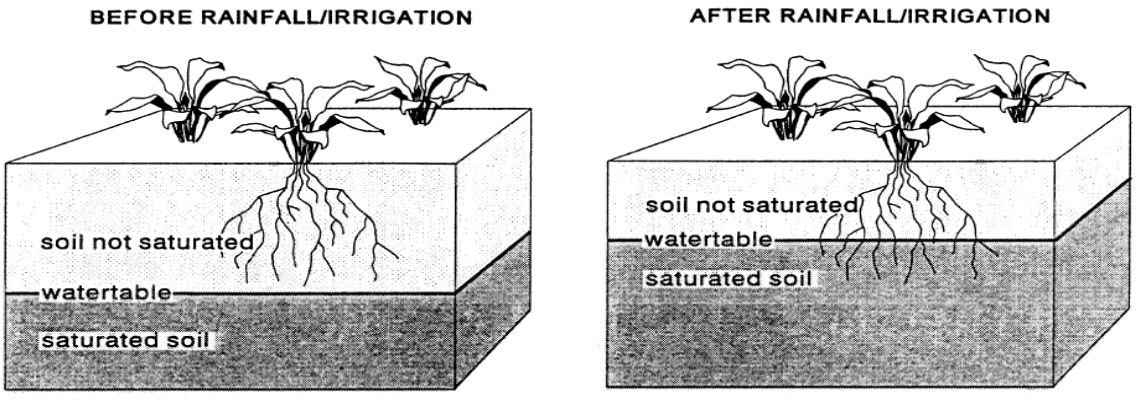

Fig 2.2 after irrigation or rain fall the water table rise may be reach root zone

Some crops are more tolerant to salts than others . Highly tolerant crops can withstand a salt concentration up to 10 g/l in the saturation extract. Moderately tolerant crop scan withstand up to

5 g/l, and sensitive crops up to 2.5 g/l. (For more information, see Training Manual No. 1 Introduction to Irrigation .) If sensitive crops are to be grown, drainage is needed to remove the salts. So, drainage is used to control ponding at the soil surface, to control water logging in the Soil, and to avoid salinization.

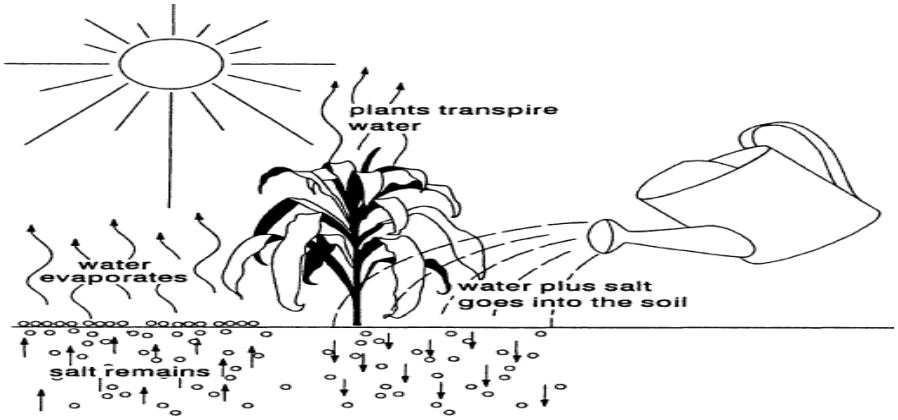

Figure 2.3 irrigation water bring salts to the soil

Drainage is the removal of excess water and dissolved salts from the surface and subsurface of the land in order to enhance crop growth

Drainage can be either natural or artificial. Most areas have some natural drainage; this means that excess water flows from the farmers' fields to swamps or to lakes and rivers.
Sometimes, however, the natural drainage is inadequate to remove the extra water or salts brought in by irrigation. In such a case, an artificial or man-made drainage system is required.

A man-made drainage system is an artificial system of surface drains and/or subsurface drains, related structures, and pumps (if any) to remove excess water from an area. Therefore drainage is needed for successful irrigated agriculture because it controls Ponding, water logging and salinity.

2.2 DRAINAGE TO CONTROL PONDING

To remove ponding water from the surface of the land, surface drainage is used. Normally, this consists of digging shallow open drains. To make it easier for the excess water to flow towards these drains, the field is given an artificial slope. This is known as land shaping or grading (Figure 5).

Surface drainage is the removal of excess water from the surface of the land by diverting it into improved natural or constructed drains, supplemented, when necessary, by the shaping and grading of the land surface towards such drains.

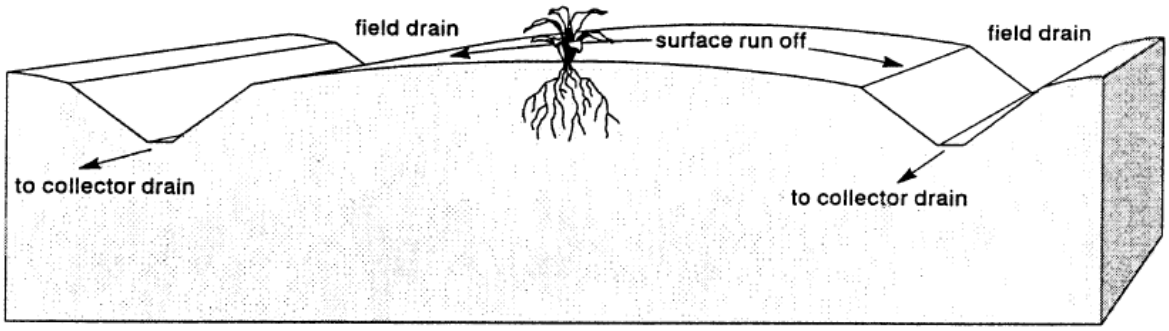

Fig 2.4 Surface drainage to remove excess water from the land surface

2.3 DRAINAGE TO CONTROL WATERLOGGING

To remove excess water from the root zone, subsurface drainage is used (Figure2 .5). This is done by digging open drains or installing pipes, at depths varying from 1 to 3 m. The excess water then flows down through the soil into these drains or pipes. In this way, the water table can be controlled.

Water logging

Water logging is phenomenon associated with rise in the ground water table. The rise of water table beyond a critical limit (usually 1.5 m to 2.0 m from ground surface), owing to poor drainage, and excessive surface irrigation practices, give rise to water logging conditions. The other distress consequences of water logging is that land turn unproductive owing to salinity and alkalinity effects arising principally out of water logged conditions. The land mass once spoilt by the salinity - alkalinity effect, cannot be reclaimed easily and are mostly thrown out of cultivation

Basic causes for water logging:

Factors responsible for water logging are broadly classified into two groups

A) Factors responsible for excess inflow:

1. Infiltration from excess rainfall - especially on flat areas
2. Flooding land - due to spills from river banks for a prolonged period
3. Induced seepage - From storage reservoirs , rivers and unlined canals
4. Over irrigation - Deep percolation losses owing to uncontrolled application of irrigation water
5. Sub-Soil flow - from areas located at higher elevation responsible for water logging of low lying areas.

B) Factors responsible for poor outflows

1. Inadequate surface drainage - due to blockage of natural drainage channels with weeds & vegetative cover
2. Natural & artificial obstructions to subsoil & surface out flow - Geological formations - owing to impervious layers of clayey or rocky strata, construction of high rise buildings, water tight reservoirs and dams with massive grouting
3. Poor topography - Flat areas with low lying depressions, in adequate land slope.

Effects of excess water on crops:

1. Evaporation - lowers soil temperature
2. Saturation or surface ponding stops air circulation in the soil and prevents bacterial activity
3. Certain plant diseases and parasites are encouraged
4. High water table limits root penetration
5. Soil structure is adversely affected
6. Salts present in the soil or ground water, tend to be concentrated in the root zone or at the soil surface and turn the soil saline/alkali and make the soil unproductive
7. Wet spots in the field ,delay farm operations
8. Excess water on surface breeds mosquitoes, insects and encourage weed growth

Subsurface drainage is the removal of excess water and dissolved salts from soils via groundwater flow to the drains, so that the water table 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.

Tube well drainage is the control of existing or potential high water table or of artisian groundwater ,through agroup of adequately –spaced wells

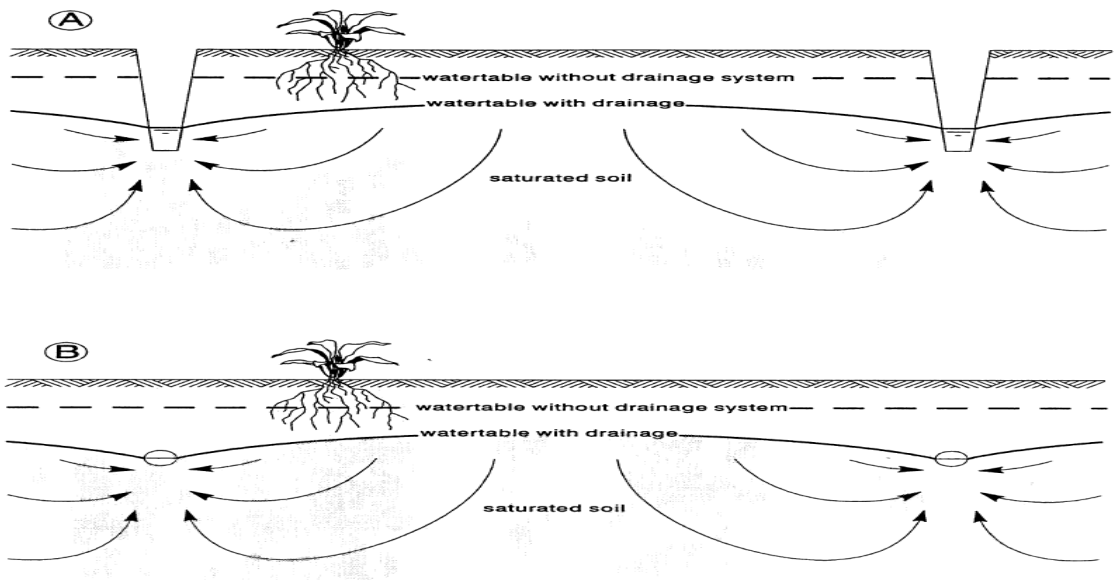

Figure 5 Field drains for surface drainage may be open (A) or pipe (B) drains

2.4 DRAINAGE TO CONTROL SALINIZATION

To remove salts from the soil, more irrigation water is applied to the field than the crops require. This extra water infiltrates into the soil and percolates through the root zone. While the water is percolating, it dissolves the salts in the soil and removes them through the subsurface drains (Figure 7). This process, in which the water washes the salts out of the root zone, is called **leaching Leaching** is the removal of soluble salts by water percolating through the soil.

The extra water required for leaching must be removed from the root zone by drainage, otherwise the water table will rise and this will bring the salts back into the root zone. Therefore salinity is controlled by a combination of irrigation and drainage.

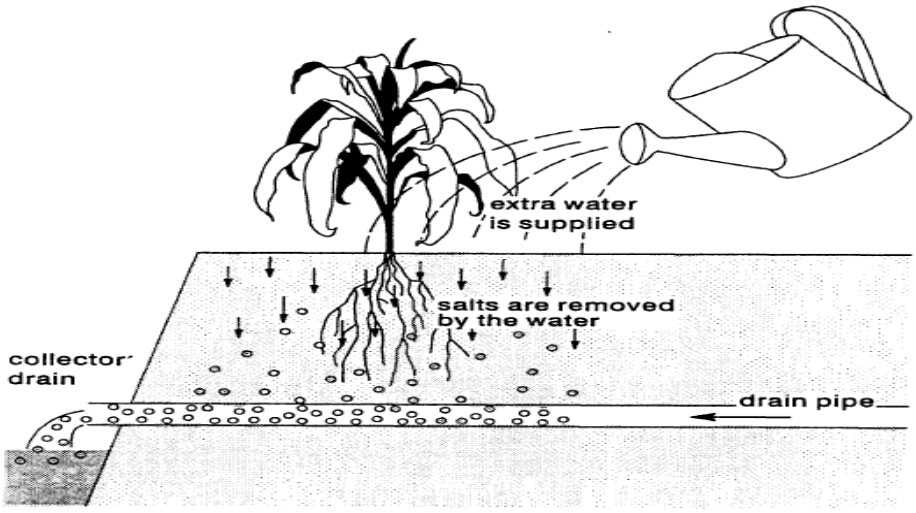

Figure 6 Extra irrigation water is applied to remove salts from the rootzone

2.5 BENEFITS OF DRAINAGE

One of the benefits of installing a drainage system to remove excess water is that the soil is better aerated. This leads to a higher productivity of crop land or grassland because:

- The crops can root more deeply.
- The choice of crops is greater.
- There will be fewer weeds.
- Fertilizers will be used more efficiently.
- There will be less de nitrification.
- The grass swards will be better.

Other benefits of well-drained soils are:

- The land is more easily accessible.
- The land has a greater bearing capacity.
- The soil has a better workability and tilth.
- The period in which tillage operations can take place is longer.
- The activity of micro-fauna (e.g. earthworms) is increased, which improves permeability.
- The soil structure is better, which also improves permeability.
- Soil temperatures are higher, so that crops (particularly horticultural crops) and grasses can be grown earlier.

When drainage makes it possible to control the water table, the benefits that follow are:

The root zone cannot become salinized by the capillary rise of saline groundwater. Leaching is made possible**.**

In its turn, the benefits of leaching are:

- It prevents increases in soil salinity in the root zone, thus making irrigated land use sustainable in the long term.
- By removing salts, it allows salt-sensitive crops, or a wider range of crops, to be grown.
- It makes it possible to reclaim salt-affected soils, thus bringing new land into cultivation.