ILLUSTRATED CONCEPTS IN TROPICAL AGRICULTURE
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WATER AND SALTS MOVE TOGETHER IN THE SOIL PROFILE

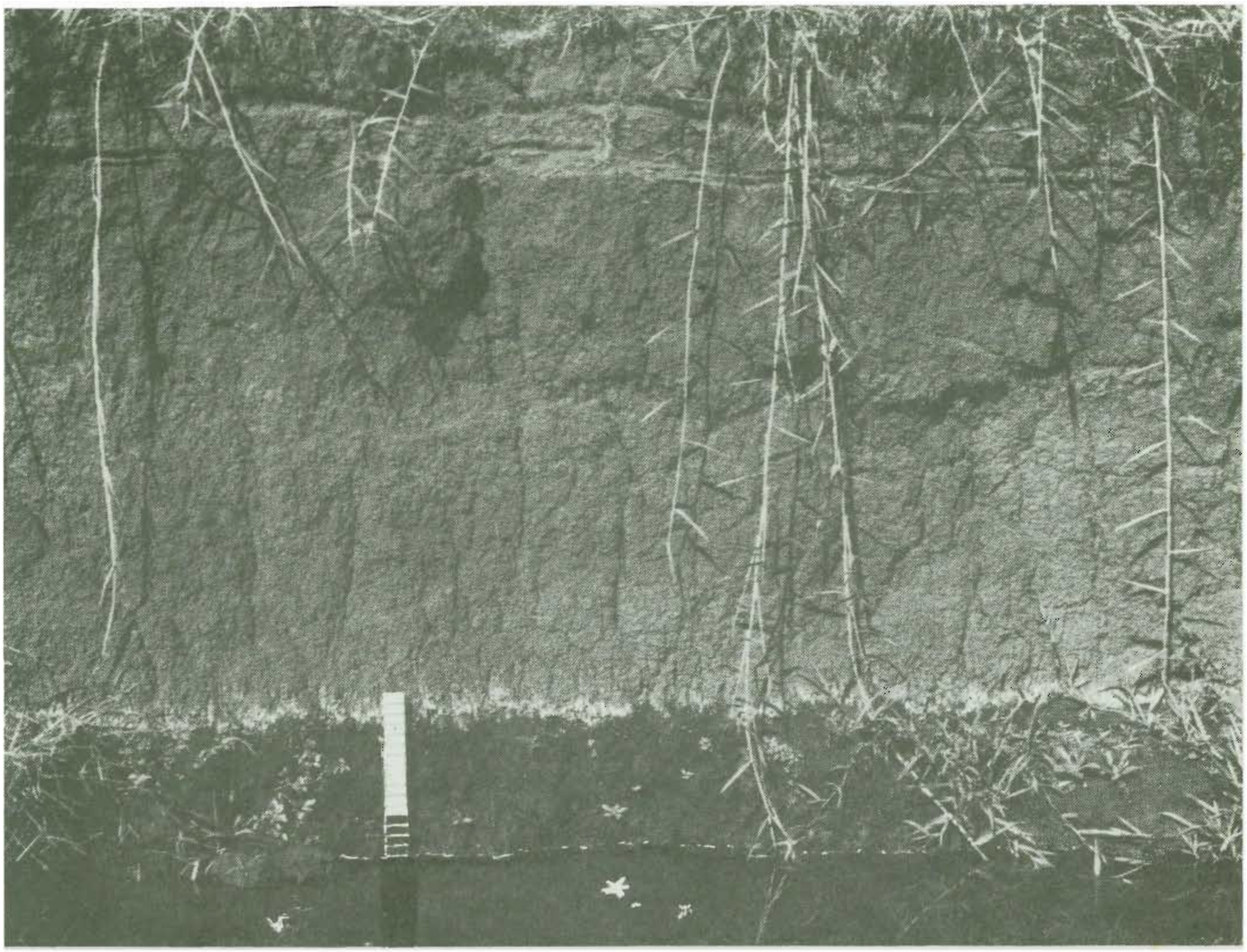

Fig. 1. A soil profile along Maunawili Stream, Kailua, Oahu, Hawaii. The crop was para grass *(Brachiaria mutica).* The photograph was taken following a period of prolonged drought.

Water in soil pores may move in any direction in the soil in response to soil-water-potential gradients (changes in water potential with distance in the soil). Soil-water-potential gradients may result from one or more of the following: rainfall, irrigation, condensation, evaporation, transpiration, or capillary movement. Water moves from points of high potential (wet soil) to points of lower potential (drier soil). In a uniformly wet soil profile, evaporation of water from the soil surface reduces the water potential at the soil surface, and in response to the decreased water potential, gravitational forces are overcome and water moves to the surface from greater depths.

A water table within a soil profile has a water-unsaturated zone above the free-water surface. This unsaturated zone, called a *capillary fringe,* varies in thickness depending on soil properties, including the size of soil pores (water rise is inversely related to pore radius) and the affinity of soil materials for water.

The maximum thickness of the capillary fringe will not be attained under field conditions as long as water from the fringe is being lost by evaporation and transpiration.

As water moves by bulk flow through the soil, it carries with it the dissolved salts of the source water, plus or minus any salts the water may gain from, or lose to, the soil during transit. Salts may be flushed from the root zone by an advancing capillary fringe, as was the case for the small plants growing just above the water table as illustrated in Fig. 1. Salts become concentrated in the root zone if water absorption by plant roots plus evaporation losses are relatively greater than salt uptake by plants. Water loss by evaporation from the capillary fringe will invariably leave behind a residue of salt. Whether or not the accumulation of salt is detrimental to crops depends on the nature and concentration of the salt and its quantity and distribution in the root zone.

Several important concepts in soil water-plant relationships are illustrated in Fig. 1.

- There is a relatively narrow (35 cm) capillary fringe. Many strongly aggregated soils with dominantly oxidic mineralogy behave in this manner to such a degree that water scarcely moves in the liquid phase at potentials more negative than −0.1 bar.
- Salt accumulation, mostly gypsum in this case, exists at the top of the capillary fringe.
- There is an absence of young plants in the salt-affected soil near the top of the moisture fringe.
- Vigorous growth of para grass during prolonged drought provides evidence that water is utilized from the capillary fringe via deeply penetrating roots.

Robert L. Fox and Richard E. Green—No. 22, 1980