

and used to obtain more reliable quantitative data on the areal distribution of usable ground water.

### Canal Leakage and Control

Most estimates of canal leakage have been based on a gross water balance and on areal changes in water table elevations. Canal leakage represents the major source of ground water recharge, therefore it would be useful to have data on leakage rates (specific leakance) of representative canal reaches. This may be accomplished by careful metering of the canal flow at two selected points as well as all diversions from the canal between these two points. Measurements should be made in canals of different ages, sizes, and operating and maintenance procedures. Canals passing through all important soil types should be investigated.

The resulting data would be valuable in determining the economic feasibility of sealing selected reaches of canals, for example, near drainage wells, and would provide a basis for comparison of the efficacy of different types of sealants.

### Water Quality Effects on Soil Properties

Water containing a high concentration of sodium ions relative to the concentration of calcium and magnesium ions when used for irrigation, can adversely affect the structure of the soil. This is particularly true for soils containing montmorillonitic clays. The sodium ion causes swelling of clay particles and reduces infiltration rates, permeability, and soil aeration. When surface water containing appreciable amounts of carbonate and bicarbonate ions are used in irrigation, dissolved calcium is precipitated in the soil and the exchangeable-sodium-ion-percentage of the pore water is increased. When this happens it may be necessary to mix ground water with fresh surface water before it can safely be re-used in irrigation.

The extent to which water quality poses problems on various soils can be studied by applying selected waters to different soils in each project area. Small ponding tests, with measurement of infiltration rates, will show the extent of the reaction under field conditions. The results will indicate quantitatively the need for soil amendments or dilution of ground water with canal water. The sodium hazard of ground waters in the Former Punjab and Former Sind merits careful investigation with emphasis on how canal water, ground water and soils can be managed so as to prevent excessive accumulation of exchangeable sodium.