

salt lagoons. Non-beneficial evapotranspiration losses will be minimized by careful water management, but these losses may actually be increased by surface storage.

Taking all factors into account, the Water and Power Development Authority of West Pakistan (WAPDA) has estimated that after construction of sufficient storage facilities, an average of some 114 MAF per year of river waters could ultimately be made available at the water courses leading to the farm fields[2]. The remaining 22 MAF would be lost, chiefly by non-beneficial evapotranspiration from reservoirs, link canals, rivers, irrigation canals, water courses, and from the border areas of all these various kinds of channels. WAPDA's estimate is based on an ultimate steady state in which only the average annual water supplies from rivers and rain can be considered. The approach to such a steady state will inevitably be slow and expensive, because it involves very extensive construction of dams, conveyance channels, and other surface water structures. In the meantime, there is an overwhelming need to increase agricultural production in West Pakistan as quickly and inexpensively as possible. Although chemical fertilizers, improved seeds, and other production factors can contribute to this end, water is the key. Here, during the transition period, we can utilize one of the great natural resources of the earth—the enormous pool of fresh groundwater that underlies the Northern Zone of the Indus Plain, and is equal in volume to ten times the annual flow of the rivers.

In making up irrigation water budgets for this transition period, we can base our calculations either on the water requirements for an assumed cropping pattern, cropping intensity, and net cultivated area, or on the estimated supplies that can be made available at a particular time with a given level of expenditures for water development. A budget based on assumed crop requirements has the advantage that the water needed during each month can be calculated. A budget based on the anticipated availability of supplies can give only seasonal totals until a cropping pattern is specified, but it has the great merit that comparisons of different cropping patterns can be made and the economic optimum chosen.

A Water Budget Based on an Assumed Cropping Pattern

Table 1 gives an irrigation water budget based on requirements for assumed cropping patterns and intensities on a net cultivated area of 19.4 million acres in the Northern Zone, and 7 million acres in the Southern Zone. The budget is computed from data given in a report by Harza Engineering Company International, made in 1963[3]. The total irrigation requirement at the water courses is 108 MAF and the beneficial use on the fields (evapotranspiration by crops *plus* leaching) is 83 MAF.