

layers of the groundwater. The flow in the main drains and laterals depends on seepage rates and these in turn depend upon the gradient of the watertable. A vertical drainage system, on the other hand, is more flexible. The flow and salinity of the mixed effluent of a set of tubewells can be controlled, and consequently, drainage can be carried out at any desired rate. This results both in a smaller investment in conveyance channels and in better salinity control, because salt can be returned to the rivers during periods of high runoff, or routed to salt lagoons at times when the irrigation requirement is small.

Compared with vertical drainage, horizontal drainage systems are wasteful of water. The salinity concentration of the drained water is likely to be smaller than with tubewell drainage and hence larger amounts of water must be carried away in the drains.

2) In flat topography it is difficult to fit together efficiently a horizontal drainage system with an intensive irrigation system. Crossings of conveyance lines of the two systems are unavoidable and are expensive. If the drainage is to be returned to the canals, pumps are required. The principal costs of horizontal drainage in the Indus Plain would be associated with pumps and with concrete control and access structures including weirs, gates, check stops, bridges and pump sumps that cannot be built with unskilled labor.

3) Irrigated agriculture is most successful when it is most intensive, that is when it is concentrated on a minimum land area. Open drain systems occupy a significant portion of the land area in and between the cultivated fields and hence cause the farming operations to be spread out on more land. While it is true that the supply of good land is greater than the supply of water throughout most of the Indus Plain, the layout of an extensive horizontal drainage system, which must conform to the topography and have a minimum number of intersections with the distribution system, will extend and complicate the access routes to the fields. Farming operations are impeded when bridges must be crossed.

4) Deep main drains and open field drains are difficult to maintain. Drainage works are sporadically impaired by flood damage and their efficiency is regularly reduced by growth of weeds. Flood damage to drains is inherently more serious than the damage to water distribution channels because of topography. Unless pumps are used, artificial drainage must conform with natural drainage. Consequently the drains must be adequate to handle storm runoff and must be repaired after the floods recede. Weed growth in drainage ditches is more abundant than in distribution channels because of lower flow velocity and greater nutrient supply. Maintenance of drains—removal of weeds and debris, channel realignment and repair of side slopes—is difficult and unpleasant work. Even a cow does not like to descend into the weedy morass of a malfunctioning drain.