IGHT IRRIGATIONS WITH LEVEL BASINS--A NOVEL APPROACH[1/]

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Level-basin irrigation involves applying water to a level ground area, of any shape, which is surrounded by a dike or other control barrier. The water is generally applied more rapidly to basins than to conventional sloping surface irrigation systems. When basins are properly designed and have uniform soils, they inherently allow for uniform and efficient irrigations without runoff, are relatively easy to manage, and in many instances, are labor saving(1,2). The water is confined within the basin until absorbed by the soil. Recently, I studied a level-basin system in which part of the applied water can be drained from the basin surface after water advance has been completed.

Surface drainage of level basins provides a unique opportunity to apply lighter irrigations, to larger basins, than has been possible with conventionally managed basins. Basins are generally best-suited for medium-textured soils with high water-holding capacities in which root zones can be well developed, and with good internal drainage. If those conditions do not exist, then small water applications are needed to maintain high efficiencies and optimum soil, water, and air conditions for plant growth. On sandy soils, the main reason for light application is the limited water-holding capacities; and on heavy clay, to prevent water logging which can cause serious aeration problems.

The key to design of level basins on heavy clay soils centers on the amount of water that can be infiltrated before "scalding" or oxygen deficiencies occur. This amount of water (depth infiltrated before scald) criterion is different from that typically used on a "more forgiving soil." Surface-draining level basins could have application in the Imperial Valley as well as many other areas. I will describe the physical layout of the surface-draining level-basin system by the use of photographs and a sketch of such a system being used by Compadre Ranches in the San Luis Valley in southern Colorado. Some preliminary data will be presented for studies recently completed on the ranch.

How the System Works

The main difference between the surface-drained level basins and conventional level basins is the way in which the water is conveyed and distributed to the basins. With conventional level basins, the water is turned into the basins from a canal or pipeline controlled with gates. With row or bed crops, secondary (temporary) ditches or channels are used to spread and divert water into the furrows. Once the required volume of water is applied to a basin, the gate is closed and the irrigation is complete.

In the surface-drained level-basin system, the secondary channel (not temporary in this case) not only spreads and diverts the water but also conveys the water to the basins. The system utilizes a series of level basins, each irrigated separately by checking the water (check gate) in the supply channel at a drop to the next basin (Fig. 1). Once

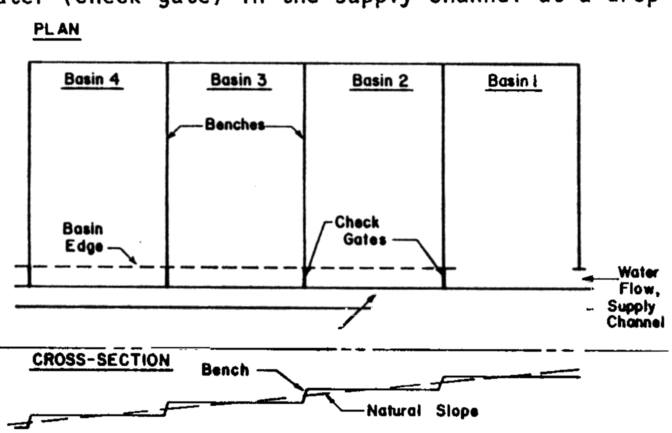


Fig. 1. Field layout (plan view) of surface-draining level-basins and cross-sectional view of benched system.

[1/] Contribution of the Agricultural Research Service, U. S. Department of Agriculture.

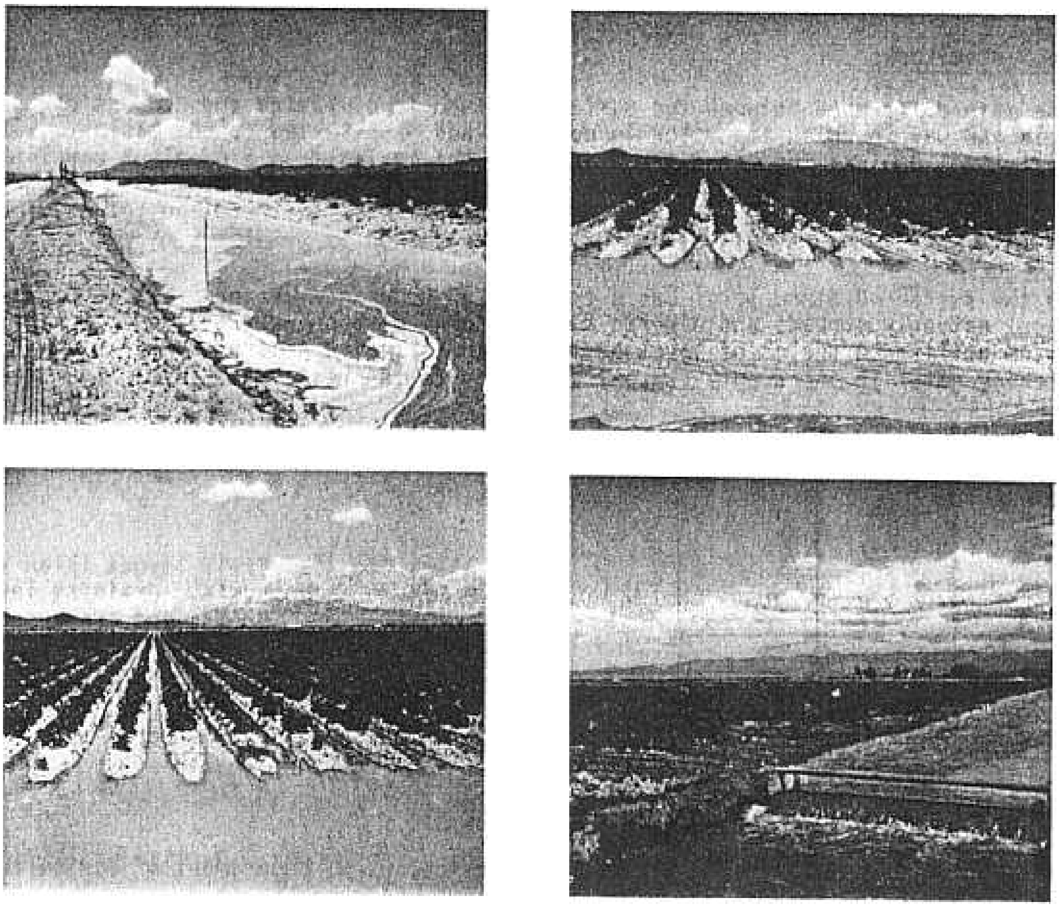
checked, the water rises in the channel and flows out onto the basin. The irrigation is switched to the next, lower-lying basin by opening the check gate. The system is designed so that the water level in the channel drops below the surface of the basin just irrigated. Water flowing past the first basin is checked at the lower basin, which starts the irrigation at that basin. This switching sequence and physical layout of the supply channel provide the uniqueness of the system in that a portion of the water applied can be drained back into the supply channel. The result is a net irrigation depth (volume) that is less (by the portion drained from the basin surface) than when conventional level-basins are used.

A series of photographs, Figs. 2 and 3, is shown to illustrate the system. All

Fig. 2. Supply channel--road on left and basin on right. Check gate is in background.

Fig. 3. Supply channel sequence during irrigation, (a) filling after water had been checked; (b) water level rising, about to enter furrows; (c) furrows being irrigated; and (d) after check gate removed and water being conveyed to a lower-lying basin. Water is still draining back out of furrows into channel.

(a) (b) (c) (d)



photos were taken during an irrigation on Compadre Ranches. Potatoes were being grown on the level furrows. The supply channel is shown in Fig. 2 and in cross section in Fig. 4.

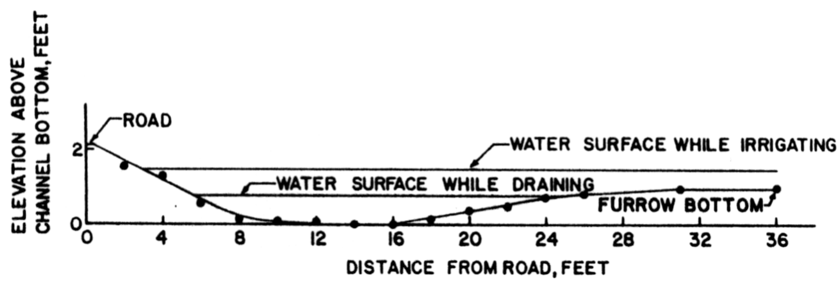


Fig. 4. Cross sectional view of supply channel from the road to the basin. The water surfaces shown were those recorded during an irrigation, with the maximum depth reaching about 0.5 ft. Note that the vertical and horizontal scales are not the same.

Actual water surface elevations are shown during irrigation and also during the drainage period. Water depth was about 0.5 ft over the bottom of the furrows. For this specific supply channel cross section, flows could range between 15 and 25 cfs. Water is just entering the checked channel in Fig. 3(a), is about to flow into the furrows in Fig. 3(b), and is flowing into the furrows in Fig. 3(c). Fig. 3(d) shows the supply channel after the check gate was removed and irrigation had progressed to lower-lying basins.

Field Study--An Example

Some statistics from an irrigation of one basin were:

Basin Size: Length 590 ft, width 490 ft, area 6.64 acres

Number of Furrows: 173

Row Spacing 34 in

Soi Type: Sandy loam with moderate intake rate

Irrigation Time (time between opening of check gates): 36 min.

Flow Rate (nominal): 23 cfs

Depth Applied (gross until cut off): 2.10 in

Furrow Surface: Smooth

Water Advance Time (time for water to reach far end of furrow, average rate 15 ft/min): 35-45 min.

Flow Rate per Furrow: 0.13 cfs (60 gpm)

Maximum Furrow Depth: 0.6 - 0.7 ft

Maximum Flow Depth in Furrow 0.5 ft

Four furrows were studied in detail during the irrigation to evaluate the amount of water actually drained after the irrigation was switched to a lower basin. Preliminary evaluation of the field study indicated that between 40 and 50 percent of the water in the furrow, at the time of switch, drained back into the supply channel. The rest was infiltrated. Total volume of water in the furrows at switch ranged from about 150 to 170 ft^3 (equivalent to 1.1 to 1.2 in). Drainage amounted to about 65 to 70 ft^3 (equivalent to about 0.5 in). Hence, the net irrigation depth on the basin was about 1.6 in, which is about 25 percent less than if the irrigation had been done conventionally.

Looking at two of the furrows in more detail, the portion of water drained from a furrow decreased with distance from the inlet, Fig. 5. This was expected but is

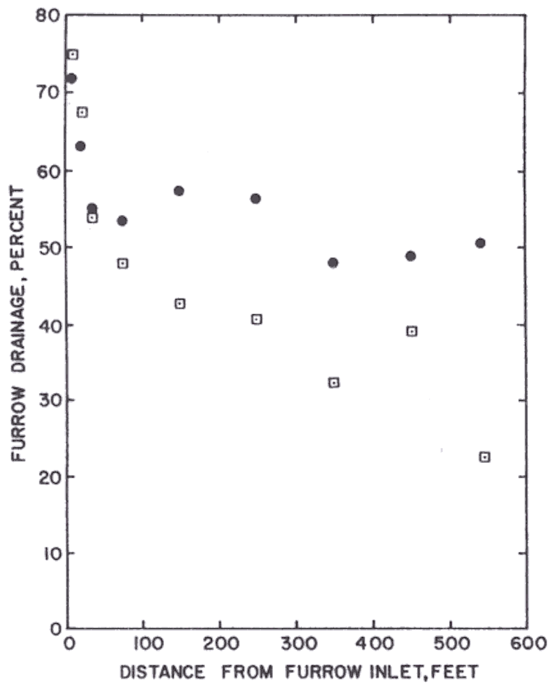


Fig. 5. Portion of water which drained from two furrows relative to location within the furrow. The average drained from the furrows was about 53 percent of the water in the furrow at the time of switch for the furrow represented by the solid dots and 41 percent for the other.

representative of only the particular site conditions. The exact portions of water going to infiltration and drainage will depend on the intake characteristics of the soil, length and cross section of the furrow, volume of water in the furrow at the time of cutoff, and surface roughness. In addition to "light" applications, the irrigation must also be uniformly applied, e.g., "light-uniform" application. Management guidelines will need to be perfected to assure the desired uniformity. For example, on low intake soils, water may need to be detained on the basin for a period of time to insure adequate infiltration before surface drainage is allowed.

Design Considerations

Some field cross-slope (natural gradient) is required to provide the necessary drop (bench) distances between basin levels, Fig. 1. The drop must be greater than the flow depth in the supply channel when water is being conveyed. The amount of drop needed for a specific site can be designed by adjusting the supply channel width, e.g., a wider channel results in less depth of flow and hence less drop is required. The minimum width is controlled by (a) a limiting water depth dictated by the natural slope of the land in the direction of the channel, Fig. 1, and (b) a nonerosive flow velocity. Natural slope also dictates the basin width relative to the drop selected. Once basin width and unit flow rate (cfs/ft, gpm/furrow, etc.) are known, then the total flow rate needed and the corresponding supply channel width can be determined.

References Cited

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Acknowledgments

The author expresses his appreciation, on behalf of the Agricultural Research Service, to Vess Quinlan for making Compadre Ranches, in the San Luis Valley of Colorado, available to us in order to evaluate the level-basin system as it is currently being used.