SURFACE RUNOFF IN DAIRIES

A. C. CHANG · K. AREF · D. C. BAIER

Hydrologic analysis indicated that surface runoff from manure accumulated in dairy areas would not occur very frequently in southern California. This was verified by a field test using simulated rainfall. Hydrologic data collected in this experiment were used to establish the runoff-rainfall relationship for the Chino-Corona dairy preserve. Although the amount of runoff may not be large, the high mineral and organic carbon contents of manured runoff is detrimental to the water quality of receiving streams. The high salinity and low nutrient content would make it possible beneficial use on cropland seem doubtful. In wet years, the disposal of salt-laden wastewater could become a problem. Holding ponds and retention structures for surface runoff merely prevent it temporarily from entering the receiving water.

Surface runoff from livestock-manured areas usually carries a high water pollution potential. Researchers in Texas, Nebraska, and Kansas have characterized the surface runoff from beef cattle feedlots by its high biochemical oxygen demand, nutrient contents, and mineral constituents. Although dairies differ from feedlots in feed rations, animal stocking rates, etc., runoff from dairies is not expected to differ much from that of feedlots. In an area with a heavy concentration of livestock, such as the Chino-Corona dairy preserve in southern California, manure-laden runoff could be a significant portion of the total surface runoff of the watershed and could degrade the quality of the receiving stream. This study was an attempt to determine the hydrologic and water quality characteristics of surface runoff from this area.

Rainfall simulation

A pre-experiment hydrologic analysis was conducted to determine the precipitation pattern of the study area. Data used for this analysis were obtained from a gauging station of the San Bernardino County Flood Control District, located at lat. 34°58', long. 117°36', with continuing record dated back to 1940. The result indicated that the annual rainfall at the dairy area ranged from 3.98 inches to 27.66 inches, with annual average of 11.67 inches. A 24-hour storm occurring at ten-year intervals produces 3.95 inches of rain. Further analysis of the magnitude and distribution pattern of daily rainfall indicated that precipitation was infrequent. In the past 32 years (1940–1972), recorded daily rainfall for 97.8% of the days was less than 0.5 inches, and considerable time would have to elapse to accumulate enough runoff data for analysis.

Instead of waiting for runoff-generating storms, researchers simulated precipitation on the surface of dairy corrals where animals are confined. A simple rainfall simulator was fabricated by using 2-inch OD schedule 40 PVC pipe with spraying nozzles on 8-inch risers spaced 5 ft apart. It produced simulated rainfall with intensity ranging from 0.5 inches per hour to 2.50 inches per hour, at a uniformity coefficient ranging from 81 to 96 (uniformity coefficient of a perfect distribution pattern is 100). It covered a strip of corrals surface 15 ft wide and 200 ft long. In comparison with natural rainfall, the simulated rainfall had two shortcomings. First, the simulated raindrops did not travel sufficient distance to reach the terminal velocity of natural raindrops, so they did not have the impact momentum of natural raindrops when they reached the ground. Second, with the non-

J. D. Rudewald is Extension Nematologist, and F. Shibuya is Research Staff Associate, Cooperative Extension Service, University of California, Riverside. D. G. Kontaxis is Farm Advisor, Imperial County.
rotating spraying nozzles water drops tended to fall on the same spot each time. In natural rainfall, water falling on the ground surface is only slightly contaminated. However, this is not true of simulated rainfalls using well water. But after a comparison of the quality of water used and runoff collected, it was concluded that runoff water was so contaminated that the amount of minerals in the ground water would not seriously affect the result.

On each simulation, the device was set up at a dairy with a 3.2% ground slope. The overland flow from the test area was measured by a precalibrated V-notch weir. Water samples were taken at the same time and returned to the laboratory for water quality analysis.

Characteristics of runoff

The hydrologic characteristics of each delivered precipitation and its resultant runoff are summarized in Table 1. In this table, the waste accumulation condition was described by the number of days after corral cleaning, on the assumption that the time of collection was representative. The overland flow from the test area was measured by a precalibrated V-notch weir. The waste accumulation condition was described by the number of days after corral cleaning, on the assumption that the time of collection was representative.

Water quality

Surface runoff was high in water pollution potential (Table 2). The result is in general agreement with findings of other researchers. It can be categorized by high mineral and high organic carbon content, which makes it unsuitable for direct discharging into a surface stream. Judging from the high electric conductance and monovalent cations, it would not even meet the quality requirement for irrigation. Although the loss of dissolved minerals to surface runoff was significant, the transport of suspended solids by overland flow did not appear to be a serious problem on the mild-sloped land. Comparing with studies of other researchers, where slopes were steeper, precipitation higher, and the rainy season longer, the suspended solids in the surface runoff were significantly less. Overland flow traveling a long distance tends to form channels; this channelled flow with high velocity would transport larger amounts of loosely-packed wastes. Under experimental conditions, no channel was formed. This leads to the conclusion that a well-sloped corral surface would minimize the loss of suspended material through runoff.

A. C. Chang is Agricultural Engineer, Department of Soil Science and Agricultural Engineering, University of California, Riverside; X. Aref is Environmental Quality Specialist, California State Water Resources Control Board, Sacramento; and D.C. Baier is Water Quality Management Consultant, Woodland, California.