

Drip Irrigation

In this system plastic pipes laid on the surface of the ground deliver water to plants drop by drop. The system reduces stress on the plant, conserves water and works well with saline water

by Kobe Shoji

Some 40 years ago Symcha Blass, an Israeli engineer, observed that a large tree near a leaking faucet exhibited a more vigorous growth than the other trees in the area, which were not reached by the water from the faucet. Blass knew that conventional methods of irrigation waste much of the water that is applied to the crop, and so the example of the leaking faucet led him to the concept of an irrigation system that would apply water in small amounts, literally drop by drop. Eventually he devised and patented a low-pressure system for delivering small amounts of water to the roots of plants at frequent intervals. The technique, as developed by Blass and subsequently refined by him and various manufacturers, consists in laying a plastic tube of small diameter on the surface of the field alongside the plants and delivering water to the plants slowly but frequently from holes or special emitters located at appropriate points along the tube. The concept, which is now called drip irrigation or trickle irrigation, has gained wide acceptance, proving to be particularly valuable in areas that are arid and have high labor costs. An unforeseen benefit is that the system works well with water that is highly saline, as water in arid regions often is.

In much of the world farmers still irrigate as they did 5,000 years ago, either by flooding their fields or by diverting water to the crop through parallel furrows. In these methods of irrigation the plants take up only from 30 to 60 percent of the water that is applied. Moreover, the preparation of the field and the management of the irrigation system require much labor. If water is plentiful and labor is not too costly, the furrow method may have an economic advantage in spite of its inefficiency. In areas such as California and Hawaii, however, which face not only water shortages but also rising labor, power and water costs, drip irrigation has been rapidly and successfully adopted. Indeed, California, where last year was the third-dri-

est on record, now has 15 percent of the worldwide total of some 162,000 hectares (400,000 acres) with drip-irrigation systems.

The basic idea underlying drip irrigation can be traced to experiments in Germany in the 1860's. Farmers laid clay pipes with open joints about .8 meter below the surface of the soil in an effort to combine irrigation and drainage as the water table rose and fell during the year. In the 1930's growers in Australia with limited water supplies devised a system for irrigating peach orchards with five-centimeter galvanized-iron pipes in which holes had been cut with a chisel. Greenhouse operators in the United Kingdom began to try a similar method in 1948 for the growing of tomatoes.

Drip-irrigation techniques were first introduced into the U.S. in the early 1960's, when a number of operators in the nursery industry installed the system in greenhouses. It was applied to orchards and row crops in California beginning in 1968; since then it has been adapted to other crops, including tomatoes, grapes, strawberries, corn, pineapples and sugarcane. (Drip irrigation is not suitable for closely planted crops, such as cereal grains and alfalfa, because the amount of tubing they require makes the system uneconomic.)

When Blass conceived the idea of drop-by-drop irrigation in the 1930's, the materials needed to build a low-pressure system at reasonable cost were not available. Only with the rapid development of the plastics industry after World War II could appropriate materials for making chemically resistant, flexible lines of small diameter be produced economically. The earliest drip-irrigation systems consisted of plastic capillary tubes of small diameter (one millimeter) attached to larger pipes. Friction in the tube restricted the flow of water into the soil from a given discharge point to between two and four liters per hour. The system was initially

installed underground, but because of the primitive filtration techniques of the time and frequent clogging the distribution apparatus was moved above-ground. This change made it easy to check the tubes for clogging and maintained the chief advantage of the system: the direct application of water to the root zone of the plant.

One of the refinements made by Blass in his original system was a coiled emitter that he designed to prevent clogging. It consisted of a spiral tube in a hard casing. The tube served to reduce the discharge pressure by lengthening the flow path of the water, thereby making it possible to discharge the water through a larger hole.

In the 1960's experimenters in Israel reported spectacular success when they applied the Blass system in the desert areas of the Negev and the Arava. Yields there had been poor with both furrow and sprinkler irrigation. The main reason was that the water was quite saline. Drip irrigation can generally utilize water of higher salinity than would be acceptable with other methods of irrigation, a subject to which I shall return.

The conditions for agriculture in the desert areas were distinctly adverse: not only saline water but also high temperatures, low relative humidity and sandy soil. In spite of these difficulties the drip-irrigation technique brought about a substantial improvement in crop yields. For example, a field trial in the Arava produced annual harvests of almost 58.3 metric tons of winter tomatoes per hectare with drip irrigation, compared with 35.8 metric tons with sprinkler irrigation. In another trial the yield of muskmelons was increased by 70 percent, and salt-sensitive crops such as cucumbers showed significant yields for the first time. Moreover, drip irrigation demonstrated such additional advantages as a diminished consumption of water, a reduction in labor costs and an improved distribution of fertilizer. A soluble fertilizer can easily be distribut-