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IRRIGATING WITH UNDERGROUND WATER

By T. C. CALDER, Irrigation Technician, Harvey, and K. S. COLE, Irrigation Adviser, South Perth.

MANY farmers in South-West areas are looking to irrigation to increase and diversify farm production, particularly on the sandy coastal plain where irrigation in summer is essential for vegetable, fruit and fodder production.

Water for the State-controlled irrigation areas between Waroona and Donnybrook comes from large storages in the hills, but other west coastal areas rely mainly on underground water.

The narrow coastal strip between Geraldton and the south coast, bordered by the ranges and the sea, coincides with the Perth Artesian Basin. This basin contains three types of underground water—

- Artesian water, which is under pressure and flows to the surface.
- Sub-artesian water, which is under pressure but does not reach the surface and must be pumped.
- Groundwater, which is not under pressure but can be drawn from bores, wells and dragline holes by pumps and mills.

On the western edge of the basin is a limestone water-bearing zone, or aquifer, containing reasonable quantities of good quality water suitable for irrigation. To the east of the limestone aquifer is another groundwater source with water which is not always suitable for irrigation. Sub-artesian water is available in various areas, but the quantity or quality is often unsuited to irrigation.

The artesian aquifers are normally deeper than 300 ft. and contain large amounts of water, but quality varies considerably. Some artesian bores are totally unsuited for any form of irrigation, while others are suitable for all crops.

Limestone aquifer

The limestone aquifer contains water which is usually very suitable for irrigation. Total dissolved salts are low and the levels of dissolved iron are extremely low. The overlying soil, known as Tuart sand, is well suited to the production of vegetables, potatoes, flowers and lucerne.

Unfortunately the aquifer is not continuous and potential water yields vary greatly. In some cases yields are too low for an economical pumping scheme. Generally, bores range from 5,000 to 25,000 gallons per hour.

The depth to water is up to 30 ft. and in many cases there is sufficient pressure to cause the water level to rise to within 12 to 15 ft. of the surface. At this shallow depth a well will be cheaper to construct than a bore and the low lift enables a centrifugal pump to be used. These factors combine to help keep down the capital costs of the water supply.

The sandy soils are unsuited to flood irrigation, and heavy infrequent waterings are of little value. Sprinklers are normally used to provide frequent watering for crops and pastures.

Market gardens using water from this aquifer supply most of the vegetables for Perth. Dairy products, beef, grapes and other fruit are also produced under irrigation.

Greater use of the water in this aquifer can be expected in the future. Trickle irrigation has been used successfully on vegetables and vines, and results with other crops will be watched with interest.
Shallow aquifers east of limestone

The sub-artesian and non-artesian aquifers east of the limestone are very variable in quality. Total dissolved salts may be quite low or so high as to make the water useless for irrigation. Nearly all the water in these aquifers contains dissolved iron, which causes a heavy brown stain on plants and buildings.

The soils overlying many of these aquifers are poorer quality sands in the west, with very poor sands in the middle areas, grading into better sands and even loams in the east. Unfortunately, water quality often deteriorates from west to east.

The aquifers are from a few feet to several hundred feet below the surface. The water is not under pressure in most cases and yields vary from several hundred gallons per hour to many thousands of gallons per hour. Before using water from this aquifer it is essential to test its quantity and quality.

Artesian aquifer

The artesian aquifer is an important source of water for town supplies as well as agriculture, but not all the supplies obtainable are suited to agricultural or human use. In most cases the quantity increases and the quality decreases with increasing depth. Salt damage and iron staining have been reported on a number of occasions.

Where quality and quantity are suitable, artesian water has been used to maintain green pastures for beef and dairy cattle in summer.

The aquifer is from 300 to 1,500 ft. or more below the surface and quantity varies from 5,000 to 50,000 gallons per hour depending on depth. The water will overflow the casing and is sometimes under considerable pressure. Once pumping starts the drawdown or recession in level is usually such that centrifugal pumps will not operate, and more expensive pumps must be fitted.
Before drilling an artesian bore, permission must be obtained from the Public Works Department (see article on Rights in Water Act). Specifications for artesian bores must be followed.

Watering needs

It is not generally realised that very large quantities of water are needed for irrigated pastures and crops, and a large, reliable source of groundwater must be available. The following examples show the water needs of various crops.

- A permanent pasture may need 36 inches or more of water over the summer. This is usually given as nine waterings, each of 4 inches (90,000 gallons per acre) during the summer. On sandier soils some farmers prefer to give 12 waterings, each of 3 inches.
- Crops such as forage sorghums need 15 to 18 inches in five or six waterings as a minimum if high yields are to be obtained. In a long dry summer more waterings will be needed.
- Potatoes will need 20 to 24 inches and vegetable crops generally less as they grow for shorter periods but require more frequent waterings because of shallow root systems.
- Fruit trees may require up to 36 inches and vines less, depending on variety and what is to be the ultimate use of the fruit.

Watering methods

In the case of trickle irrigation, relatively small amounts of water are applied at very low rates of application. A trickle scheme will only work well when properly designed for the particular site, and expert help should be sought.

Where flood irrigation is to be used, soils and topography must be suitable and water quality and quantity adequate. Taking as an example a bore equipped with a deep well submersible turbine delivering 22,500 gallons (approximately 1 acre inch) per hour for 20 hours per day, it will be possible to apply 4 inches of water to 5 acres per day, or 70 acres in a fortnight. This does not allow for any seepage losses in the channels or for overruns in watering. Seepage losses can be quite high and could account for a considerable proportion of the water pumped.

Mechanical breakdown or excessively hot, dry weather can cause the system to fail. There is an added four hours per day pumping time...
not being used or 56 hours in a fortnight when repairs and maintenance can be attended to or extra water applied. In mild weather it would be possible to stretch the watering period to 18 days in an emergency.

Where soils are not suited to flood irrigation a similar pump installation can be used with sprinklers to deliver one inch per hour to a strip 10 chains long and 60 ft. wide. The sprinklers would be 30 ft. apart in the line with twin nozzles \( \frac{1}{4} \) in. x 3/16 in. and operating at 50 p.s.i. The line would have to be moved every 3 or 4 hours for 20 hours per day. Alternatively, a self-propelled sprinkler may be used to deliver the water.

**Economics**

The economics will vary with every scheme, but all the following should be assessed during planning—
- extra labour to control the water,
- extra fertiliser for the crop or pasture to make use of the applied water,
- cost of pumping and distributing the water,
- capital outlay and depreciation,
- extra fencing to control stock on irrigated pasture,
- maintenance of facilities,
- expected increased returns from the enterprise.

All too often the returns do not outweigh the costs, as planning was based on exaggerated returns. Small schemes are always more doubtful than large schemes and high return crops safer than low return crops.

Farmers contemplating any type of irrigation would be well advised to work out all the costs and likely returns before they invest in an irrigation scheme. Irrigation can be very profitable under the right circumstances, but where conditions are not right, financial embarrassment may result.

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**NEW CHIEF FOR WHEAT AND SHEEP DIVISION**

The new Chief of the Department of Agriculture's Wheat and Sheep Division is Mr. W. J. Toms, formerly the Division's Assistant Chief. He replaces Mr. T. E. McDowell who was appointed Assistant Director of Agriculture in September.

Mr. Toms joined the Department in 1953 as a Research Officer in the Plant Research Division, and from then until 1961 worked on research into pasture establishment and the nutrition of cereals and pastures, mainly in the cereal-growing areas. He carried out the research which led to the Department's first recommendations on the use of nitrogen fertilisers for cereal growing and was closely involved in preliminary research for the War Service Land Settlement projects at Eneabba, Jerramungup and Gairdner River.

In 1961 he was posted to Kununurra to grow the first commercially-sized Ord River cotton crop, and, until 1963, studied the problems of cotton growing to provide the necessary background for the first commercial crops on the Ord.

He was appointed Agronomy and Experiment Officer in the Wheat and Sheep Division in 1965. In this position he was responsible for the Cereal Laboratory, cereal breeding, and variety testing and co-ordinated the Division's crop and pasture research programme.

In December, 1969, he was made Assistant Chief of the Wheat and Sheep Division where he was responsible for plant breeding and cereal variety testing, as well as helping with the administration of the Division.

He visited Japan earlier this year to look into that country's quality requirements for W.A. wheat. The report of his visit has already influenced the recommendations affecting the varieties and areas sown to wheat in this State.

Mr. Toms received his secondary education at Perth Modern School, and completed the degree of Bachelor of Science in Agriculture at the University of W.A. in 1952. He was awarded a Master of Science in Agriculture degree in 1967 for research into the responses of different wheat varieties to nitrogen carried out while he was a research officer in the Department of Agriculture.