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NORTHERN WHEATBELT
WATER SUPPLY STUDY

By I.A.F. Laing, Senior Research Officer, Irrigation and Water Resources Branch and R.M. Pridham, Technical Officer, Geraldton Regional Office

Department of Agriculture surveys have shown that many farms in Western Australia's northern wheatbelt have inadequate water supplies. More than 80 per cent of all farms in that area depend solely on groundwater for watering livestock, a much higher percentage than for most other farming areas. Because groundwater salinities have increased in recent years, concern is held for the long-term future of this resource.

In contrast to more southern agricultural areas, farm dams in the northern wheatbelt are relatively uncommon. Only 30 per cent of the existing dams in the northern wheatbelt constitute effective water supplies. More than half of the ineffective dams regularly go dry, caused by those dams being too small and too shallow, or by an inadequate catchment, or both.

Some of these water supply problems are undoubtedly of a chronic or long-term nature, but it also seems likely that some are related to below average rainfall in recent years.

As an example, the 62-year average annual rainfall at Three Springs for 1907 to 1968 was 394 millimetres compared with the 14-year average for 1969 to 1982 of 349 mm. That indicates a 10 per cent lower average annual rainfall for the 14-year period. A similar reduction in average annual rainfall occurred at Perenjori, while many other centres had reductions of more than 5 per cent over a considerable number of years.

Two effects of such reduced rainfalls are fewer opportunities for recharge of groundwater aquifers and less surface runoff.

Partly as a result of these farm water supply problems, the Shires of Coorow, Carnamah, Three Springs, Mingenew, Mullewa, Morawa, Perenjori and Dalwallinu asked that the State Government provide a piped water scheme for the farm lands within their problem areas. Those shires have defined the problem areas as all land east and north of the Midlands railway from Coorow through to Mingenew.

The State Government’s response has been that serious consideration cannot be given to this proposal until the future prospects of piping water to those areas in the north-eastern wheatbelt which have been given first priority, have been resolved.

Experience in other farming areas indicates that the most cost effective method of solving farm water supply problems lies in the development of on-farm water supplies. Because both the Geological Survey's Hydrogeology Branch and the Department of Agriculture give advice on farm water supplies in the northern wheatbelt, and are therefore interested in the area's special problems, two major programmes have been started. Those programmes were designed to investigate groundwater salinity trends in northern wheatbelt bores—the Winchester Catchment Study—and to demonstrate that suitably constructed farm dams and catchments can be successfully used for farm water supplies in these areas.

Bore water salinity

In 1981, the Department carried out a preliminary study into bore water salinity, using data from the Geological Survey bore census for the northern wheatbelt. The study area extended north from Coorow and Dalwallinu, and east of the Midlands railway from Coorow through to Mingenew. It covered an area exceeding 750 000 hectares in which more than 700 000 sheep would normally graze.

The investigation indicated that there was a general rise in groundwater salinity from 1968-69 to 1976-77, with a 17 per cent increase in salinity in a random sample of 76 bores used for watering livestock. The average water salinity of the bores rose from 3 700 milligrams per litre total dissolved solids (T.D.S.) in 1968-69 to 4 400 mg/L T.D.S. in 1976-77.
This preliminary analysis of groundwater quality indicated the need for a more precise study. It was decided that the Winchester Catchment Study should be undertaken to identify trends in groundwater salinity. This joint project between the Geological Survey and the Department of Agriculture is described on page 82.

The information available on groundwater supplies also indicated that the chance of finding more usable groundwater on most farms was poor.

**Water supply surveys**

*Three Springs*

In the late 1970s a group of farmers in a 40,000 hectare district east of Three Springs identified continuing water supply deficiencies as a major problem, and requested State Government assistance in finding a solution. To determine the nature and extent of the problems, the Department's Three Springs District Office personally interviewed 19 farmers and inspected the problem areas in 1981.

There were few, if any, water supply problems which were unique to the district. The problems of poor catchment runoff, poor soil conditions for holding water in dams (especially at depths greater than about four metres), and low success rate in locating and developing groundwater supplies had been identified in almost all other districts throughout the wheatbelt where farm water supplies had been surveyed.
Effectiveness of dams

The 19 farms surveyed had a total of 61 dams with an average capacity of 2,000 cubic metres. One of those farms had no dams. Thirty per cent of the total dam capacity was classed as being 'effective'. 'Effective' dams did not leak, were not salt-affected and went dry less frequently than one year in four. Despite this, none of those dams was regarded as drought-proof, or capable of providing a continuous water supply for a specific demand. The remainder of the total dam capacity was classed as being 'ineffective'. Twenty-two per cent of the total dam capacity leaked excessively and 11 per cent were seriously affected by salt. Thirty-seven per cent of all the dams dried out more frequently than one year in four, but did not leak and were not salt-affected.

On average, 'effective' dams were almost twice the capacity and 1.25 times the depth of 'ineffective' dams. The average area of catchment classed as 'good' on both the 'effective' and 'ineffective' dams was the same. Relatively few dams had roaded catchments. However, the 'effective' dams with roaded catchments had catchments 1.5 times larger than those on the 'ineffective' dams and they were generally of much better quality.

Bores, wells and soaks

Eighty-nine functional groundwater supplies were used regularly or could be used on the 19 farms. One of the farms had no functional groundwater supply. The groundwater supplies consisted of 71 bores, 12 wells and six soaks. About 70 per cent of the functional groundwater sources used regularly contained water with less than 5,600 mg/L T.D.S., and the remainder produced water of more than 5,600 mg/L T.D.S. As found in all other districts in the wheatbelt, the distribution of usable groundwater between the 19 farms was uneven. Some farms were relatively well-off for groundwater supplies, others were deficient.

Total farm water supply

In January 1981, the 19 farms surveyed carried 41,000 dry sheep equivalents (DSE) or about 70 per cent of the total stock numbers that would be carried on those farms in an 'average' run of seasons. Throughout the 1980-81 summer, the groundwater supplies in regular use watered a total of 39,200 DSE. About three-quarters of these were watered on supplies containing less than 5,600 mg/L T.D.S., and the remainder from supplies containing more than 5,600 mg/L T.D.S. Nearly all the livestock therefore were watered from groundwater, with less than 2,000 DSE (out of a total of 41,000 DSE) being supplied from dams or by water carted onto the farm.

This analysis, using totals for the 19 farms for 1980-81, suggests that the water supply deficiency problem was minimal. A more detailed analysis of individual farms, and considering the possibility of drought and times of 'normal' stocking rates, showed the water supply problem to be much more severe. Given the present stock numbers, in a drought year, 40 per cent of farms would have no on-farm water shortage or only a small deficiency; 30 per cent would have a moderate shortage and the remainder would face severe water shortage. In times of 'normal' stocking rates, in a drought year, half the farms would have a moderate on-farm water shortage, and the rest would have a severe water shortage.

Morawa

A similar water supply survey of 24 farms south of Morawa in 1976 showed that the same general water supply problems existed. This was because:

• Dams frequently went dry due mostly to lack of catchment runoff, although some dams leaked excessively.
• Usable groundwater was unevenly distributed between farms and very little groundwater was available on some farms.

Dam performance

The almost total dependence of northern wheatbelt farmers on groundwater is likely to be related to the relatively poor performance of small and shallow dams in this area of high evaporation. The average size and depth of dams in the northern wheatbelt are similar to those of dams in the central and southern wheatbelt, yet the annual evaporation loss in the northern wheatbelt is about two metres, compared with 1.2 to 1.5 m in central and southern districts. Livestock drinking rates are also higher in the northern wheatbelt.

Soil and geological conditions in the region may affect the adoption of surface water conservation techniques by farmers. However, the Department's observations were that although the geology in some particular areas may be a limitation, the soil conditions were generally similar (from the water conservation viewpoint) to other parts of the wheatbelt where successful dams and catchments have been built.

Three Springs project

It was decided, therefore, to demonstrate the effectiveness of surface water supplies in the East Three Springs Catchment. The project involved the investigation, design and construction of two dam and roaded catchment combinations on two properties, each of which has a history of water shortage.

In 1982, several dam sites were test-drilled with a power auger and two were selected. A water supply consisting of a dam, a natural catchment and a roaded catchment was designed for each site to provide a drought-proof water supply for 1,500 sheep.
Both dams had a four-wall construction and a pipe inlet to minimise inlet erosion, reduce sifting of the storage and therefore preserve the water storage depth and volume. This design also allows the storage of 1.0 to 1.5 m of water above ground level, which partly compensates for the limitation in depth at these sites. The table gives some details of the two water supplies.

The costs included dam and roaded catchment construction, embankments for temporary storage between catchment and dam, construction of pipe inlets and a fence around the catchment. The works were jointly funded by the Department and the individual farmers.

One of the dams had a negligible seepage rate (less than two millimetres a day) from the first filling, and was filled within the first six months. The natural catchment on this dam produced a large volume of runoff in the first year, and catering for that runoff has caused some problems. An adequate overflow is needed for the dam, and a minimum of one metre of freeboard above the overflow level.

Overall, the roaded catchment and the dam have been successful. The farmer now has a guaranteed water supply where he previously had none.

The other dam had a seepage rate of 25 mm/day when the water depth was 2.2 m in December 1983. By March 1984 the seepage rate had decreased to 2.6 mm/day when the water depth was 3.5 m. The dam is a guaranteed water supply for 1500 sheep in a part of the farm where previous water supplies had become too salty and no alternative supplies were available.

About 10 per cent of the area of the roaded catchment on this second dam is built on a self-mulching soil which could not be avoided. A soil is described as self-mulching if the surface layer is so well-structured that it does not crust and seal under the impact of rain. The dry soil surface is loose and friable. Self-mulching soils have a high clay content. They swell and shrink greatly on wetting and drying and are often associated with the 'gilgai' or 'crab-hole' phenomenon.

Self-mulching soils are known to have high infiltration rates and are generally unsatisfactory for roaded catchments. Despite the influence of this poorer section of the catchment, the 6.5 ha roaded catchment contributed more than 2200 cubic metres of water to the dam from 71 mm of rain over three days in March and April 1984. The runoff was 47 per cent.

The demonstration projects have shown that successful dams and catchments can be built in the East Three Springs district. Those soils which previously were regarded as possible problem soils can be satisfactory for dam and catchment construction.

<table>
<thead>
<tr>
<th>Details of the demonstration dams</th>
<th>Water supply 1</th>
<th>Water supply 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavated volume (cubic metres)</td>
<td>2100</td>
<td>2700</td>
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<tr>
<td>Excavated depth (metres)</td>
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<td>3.9</td>
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<tr>
<td>Storage capacity (cubic metres)</td>
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<td>Full storage depth (metres)</td>
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<td>Roaded catchment area (hectares)</td>
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<td>Natural catchment area (hectares)</td>
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<td>Natural catchment runoff potential</td>
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<td>Very poor</td>
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<td>Sheep watering capacity (DSE)</td>
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<tr>
<td>Total costs $</td>
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<td>$/DSE</td>
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<td>5.00</td>
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Test-drilling at Morawa

Similar problems to those at Three Springs occur on farms in the Morawa district. Recent test-drilling has indicated that subsoils suitable for dam construction can be found in the district provided adequate test-drilling and soil inspection is undertaken. Investigations have started on particular farms to identify the best methods of overcoming their water supply deficiencies.