Wheatbelt water supplies: prospects for the future

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Wheatbelt water supplies... prospects for the future

By J. L. Frith,
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Introduction

Ever since settlement, unreliable water supplies have plagued many of Western Australia’s wheatbelt farms. Today the main exceptions are in the 20 per cent of the wheatbelt supplied from the Government’s Comprehensive Water Supply Scheme and another 20 per cent mainly in the northern wheatbelt areas, where groundwater supplies are satisfactory. The remaining 60 per cent of farms rely mainly on surface supplies—runoff water stored in dams.

In drought years many surface supplies on farms dry up. The demand for water must be met by carting or by reducing livestock numbers. Some surface supplies fail every summer. Such was the case in the south eastern wheatbelt where the widespread combination of sandy surfaced soils and runs of low average intensity led to frequent and severe water shortages.

These circumstances contributed to the development in 1948 of the roaded catchment principle by the Public Works Department, and in 1970 of the round flat-better dam by Mr K. Shepherdson and others (Journal of Agriculture Vol. 21 No. 4, 1980). But for these two catchment aids the south-eastern wheatbelt would have only a small fraction of today’s livestock numbers.

In the central, eastern and north eastern wheatbelt water shortages on farms appeared less drastic until the 1969/70 drought, perhaps because rainfall is a little more intense and runoff more dependable than in the south east. But in 1969 and again in 1976, water shortages were widespread, accentuated by the increased livestock numbers resulting from the good seasons of the 1960s. The Department of Agriculture stepped up its water conservation research programme in response.

Survey of deficiencies

A Departmental survey of farm water supplies in an area between Beacon, Bencubbin, Gabbin and Cleary and another east of Dalwallinu showed that:

• Although groundwater from bores or wells in the area collectively had enough capacity for all the livestock normally carried in the area, its distribution was confined to relatively few farms and it was not widely available.

• Very little of this water was suitable for anything but watering sheep, which tolerate more salt than most other livestock. Furthermore the success rate for locating water and establishing bores was only 10 per cent of holes drilled, making groundwater development costly. As judged by farmers and Departmental officers the potential for satisfactory new groundwater supplies, with a few isolated exceptions, was negligible.

• Farm dams had a poor record as sources of supply. The Beacon-Bencubbin survey showed that only 25 per cent of the total dam capacity could be relied upon for satisfactory supplies. The remaining 75 per cent was subject to chronic failure.

About 30 per cent of these failures were caused by leaking. A very small proportion failed because the water became saline and the remaining two-thirds failed for reasons other than salinity or leakage.

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and does not become plastic when wet. Instead it remains in the natural aggregates in which it has weathered. The aggregates behave like coarse particles and allow water to pass between them.

In some parts of the State, dams with leaky pallid zones have been sealed by dissolving a chemical dispersant---sodium tripolyphosphate (STPP)---in the water. This causes the aggregates of fine material to break down. With this collapse of the structure, the fine material is dispersed enough to form a sealing layer. The process is attractive because the chemical is relatively cheap... and little effort is required to apply it compared to a clay lining.

Unfortunately the Department's one attempt at chemical sealing in the first unlined dam at Cleary failed completely. The dam 'piped' and the seepage rate reached 200 mm per day. This may have resulted from an overdose of chemical, but other factors could have been involved. These are being investigated before further STPP trials are started.

A dam-sinking contractor, Mr J. Pavlinovich, has played a valuable role in solving the leaky dam problem. He has selected sites and...
If we had the perfect catchment which would shed every drop of rainfall, and the perfect storage which allowed no evaporation, 1 ha of catchment would guarantee the supply needed for every 1 300 ha of land.

Storage losses from dams, other than consumption and overflow, are roughly about the same as consumption. That is, about half the water stored in a dam evaporates and about half is used. Roaded catchments can be made to yield 25 per cent of the volume of rain in a drought year. If these factors are accounted, the proportion of roaded catchment needed to provide for a farm’s stored water demand is about 0.6 per cent of area of 1 ha in every 160.

In the past decade the Department’s water conservation officers have developed a computer model called DAMCAT. This simulates a flock of sheep drinking from a dam equipped with a roaded catchment over a period of 50 to 70 years. By adjusting the size of the flock, the dam and the catchment, as well as the catchment quality, we can use DAMCAT to determine how big a dam and how much catchment would have been needed to water the sheep continuously over the period of rainfall records. Such estimates are available for 20 locations throughout the wheat belt.

To back up the model the Department has been monitoring the performance of a number of dams and roaded catchments. We also have data from two whole-farm situations in the Northam area. These indicate that DAMCAT can be relied on as the best guide to the amounts of dam and roaded catchment required for a permanent supply, drought years included.

For North Wialki, DAMCAT indicates that to water 1000 dry sheep, about 2800 m³ of dam capacity and 4 to 5 ha of roaded catchment are needed. Farms in the Beacon-Bencubbin survey average 5000 m³ of dam capacity for every 1000 sheep equivalents normally carried, but only 0.13 ha of roaded catchment. In fact only 10 per cent of dams had roaded catchment and the average size of these was 2 ha.

sunk successful dams in sand-plain country and on other soil types which we regarded previously as being incapable of holding water. These dams are mainly in very hard, cemented material, deficient in clay. Their sandy-loam texture has always been regarded as ‘poor’ for holding water.

The Department is investigating the reasons this clay deficient material holds water, and is seeking ways to recognise where this subsoil type occurs. Mr Pavlinovich has sunk a dam on behalf of the Department so that his methods could be observed during all phases of site selection and construction. Now we are monitoring this and about a dozen similar dams he has constructed. Next will come a detailed study of the materials in all of them, aimed at helping us recognise potential dam sites in light land. This may prove that there are many more potential dam sites in the north eastern wheatbelt than we accepted previously.

Where no natural dam sites can be found, we know from research done 12 years ago at Badgingarra and Forrestania that dams can be successfully and durably lined with an asphaltic sheeting membrane. This method of lining is costly, but it is cheaper than carting water.

Potential for catchment
As mentioned earlier, about 60 per cent of the dam failures in the Beacon-Bencubbin survey resulted from causes other than salinity or leaking. Perhaps some fail through being too shallow, thereby avoiding the category “failure caused by salinity or leakage”. Other dams with adequate depth to cope with evaporation loss, do not get enough runoff to satisfy the demands on them because they do not have enough catchment.

Runoff is a product of rainfall quantity, catchment area and catchment quality. Most of the wheatbelt receives less than 350 mm annual rainfall, so most people expect low volumes and infrequent runoff. Yet the demand for conserved water on wheatbelt farms is only a fraction of the quantity potentially available. It averages about 1.5 kilolitres per hectare per year. Rainfall, even in a drought year of say 200 mm annual total, can provide 2000 m³ per hectare per year... 1 300 times the demand.

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Unfortunately the wheatbelt farm water conservation story is one of preoccupation with dam capacity and neglect of catchments. Even on farms which get by with enormous aggregates of dam capacity in relation to livestock, there is a gross maldistribution of capital between two equally vital components of the water supply system.

Desalination
Reverse osmosis desalination gives a new hope for farm water conservation. Much of the wheatbelt overlies, at shallow depth, water just too saline for even sheep to drink, containing between 10,000 and 20,000 parts per million of dissolved salts.

In reverse osmosis, pressure is applied by a pump to salty water on one side of a semi-permeable membrane. A proportion of the water, but not the salt, passes through the membrane as 'fresh' water. The more concentrated solution is gradually removed through a pressure-relief valve.

The development of reverse osmosis machines is in the hands of commercial developers, in a very competitive field. These machines make relatively efficient use of energy in converting brackish water to fresh, and this, together with the potential for improvement in membrane composition and manufacturing techniques should make these machines an increasingly attractive prospect.

The Department is testing a reverse osmosis machine on a farm north of Mollerin. It takes in bore water of 10,000 parts per million (ppm) salinity at the rate of about 30,000 litres a day, to produce fresh water of 300 ppm at a rate of 12,000 litres a day. It consumes electric power at the rate of 3 kW.

Our object is simply to study the machine's operation at first hand. Like many farmers, we will be interested in the durability of its components... particularly of its expensive and somewhat fragile membranes... and its cost of operation.

Costing the alternatives
Costs must be expressed in such a way that comparisons between different types of water supply are possible. For instance, one cannot directly compare a dam reckoned in cubic metres of capacity with a bore reckoned in litres of output per day. Therefore it is convenient to assess a supply's capability in terms of the number of dry sheep it can support permanently—the 'dry sheep equivalent' (DSE). In this way the capabilities of different types of supply—dams, bores and public scheme, and different types of demand, such as garden or livestock, can be compared fairly.

For the recent Agaton study "Cost/benefit study of the north-eastern agricultural water supply (Agaton project) and the on-farm alternative"... we gave very detailed attention to the costs of systems based on dams and roaded catchments. In general an ordinary dam of about 2800 m$^3$ capacity with a roaded catchment of about 4.5 ha would provide for 1000 DSE.

Together with a mill, tank, some piping and troughs in each of several paddocks, it would have cost about $5000 in January 1981 terms. In other words the outlay cost for water to be supplied by an unlined dam and catchment would be about $5 per DSE. The cost of a clay-lined dam system is about twice this, at a little more than $9 per DSE. A system including a dam lined with a membrane would cost about $18 per DSE.

The cost of bores would vary a great deal but taking into account the success rate of 10 per cent, bores would cost about $10 per DSE.

The reverse osmosis desalinator under test produces water for an outlay equivalent to between $3 and $20 per DSE depending on the circumstances in which the machine is used. Half of this amount consists of running costs. This is a very rough estimate of an expectation.

These costs are estimates directed at average situations. There is great scope for individual situations to vary. However, the possible errors in the estimates should be less significant than the difference between the costs of different systems.