Waterspreading and waterponding in New South Wales and their relevance to Western Australia

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Abstract

During December, 1985, the author visited farms and pastoral holdings in the Condoboliri, Cobar and Nyngan areas of western New South Wales, guided by officers of the N.S.W. Soil Conservation Service. The purpose of the visit was to examine current developments in waterponding and waterspreading in New South Wales before further pursuing trials of these techniques in Western Australia.

In particular, reservations of New South Wales personnel about waterspreading systems were discussed, spreader schemes which had demonstrated problems were inspected and the operational history and current condition of long-established schemes were examined.

In the domain of waterponding, primary interest focused on current design criteria, methods for surveying ponds over large areas in the most efficient manner, and the various construction techniques which have been tried.

Information gathered in New South Wales and its relevance to Western Australia are discussed, and an outline of pilot waterponding and waterspreading schemes in this State is presented.
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1. Waterspreading

Waterspreading banks have been in use for some 30 years in western New South Wales. They serve both water and soil conservation objectives on gentle slopes (gradients generally below 3%) in lower rainfall areas (350-450 mm) of the wheatbelt. In the adjoining pastoral zone they are used in water-harvesting schemes, to permit establishment of crops or improved pastures on selected areas of otherwise low productivity country, where slope gradients are generally under 1%. Cost of banks for these pastoral schemes averages $15 per hectare, while in cropping country, depending on intensity of works required, costs are at least double this figure.

1.1 Characteristics of Spreader Banks

Conventional soil conservation banks are designed to protect soil from water erosion by intercepting runoff, storing some and disposing any surplus at one or at both ends in the case of absorption and level banks, or diverting the lot to a waterway or other safe disposal area in the case of grade banks. By contrast, waterspreading banks aim for maximum utilization of runoff by first intercepting it and then disposing it on a broad front to irrigate low rainfall crop or pasture country.

To achieve this objective, the spreader bank is constructed from the downslope side. This creates a spreader channel immediately below the bank which receives surplus runoff through regular gaps (100 to 200 metre intervals) in that bank and discharges this water along its entire length. Check banks below the gaps divert runoff flowing through them into the channel.

A spreader bank may, like a level bank, simply delay overland flow before spreading the discharge (gap spreader), it may store a certain amount on the upslope side of the bank (gap absorption spreader), or it may receive and dispose runoff diverted from an erosion gully or other drainage line or harvested from an adjacent water-shedding ridge (diversion spreader) (figure 1).

1.2 Shortcomings of Spreader Banks New South Wales Experience

In recent years the Soil Conservation Service in New South Wales has been re-evaluating the role of waterspreading banks. This has resulted from the emergence of a range of problems in established systems, often following heavy rainfall events:

- Scouring has occurred in spreader channels and through gaps.
- Banks have eroded at the ends abutting gaps.
- Check banks below gaps have been cut back.
- Bank breaching has occurred in high flows.
Sediment build-up has partially blocked spreader channels. This sediment is often the product of erosion further up the channel or through the gap.

Plant growth sometimes obstructs the spreader channel.

Overflows have concentrated at particular sections of the spreader channel. This concentration may be associated with the channel blockage referred to above, or it may occur close to a gap where high flows can discharge around the end of the gap check bank rather than spreading and overflowing along the full length of the spreader channel.

Figure 1: The three types of spreader bank. Arrows represent direction of flow of runoff.
### 1.3 Managing the Shortcomings of Spreader Banks

In western New South Wales, concern about these shortcomings has led to a shift in emphasis, particularly on cropping country, towards grade banks and waterways in preference to spreaders. Whether this shift proves temporary or permanent - may well hinge on the outcome of a formal evaluation of spreaders currently being carried out in the area.

The comments which follow, while not intended to preempt this evaluation, are the author’s personal outlook on the problems and possible solutions. They are presented now because of their relevance to current trials of spreader systems in Western Australia.

From an inspection of several waterspreading schemes in the Condobolin-Tottenham-Cobar region of western New South Wales and discussions with landholders and Soil Conservationists involved in their design, it appears there are three salient factors influencing their success or failure:

- Location and design capacity, with particular reference to the volumes of runoff that are to be harvested and spread.
- Land use (whether cropping or pasture).
- Bank and channel maintenance.

#### 1.3.1 Managing Large Flows

The worst failures seen were in systems in the pastoral zone located across drainage flats down which runoff from very large catchments (of the order of thousands of hectares) flowed, or those which were located to receive water diverted from drainage lines with a similarly large catchment.

At “Nullawarra”, south of Cobar, a flood flow several hundred metres wide and up to a metre deep wiped out a large section of spreader banks recently constructed across a drainage flat. While the bank size itself was probably too small, in the particular situation even large banks would have been badly damaged by the volume of water which flowed through the system.

At “Yaroma”, near Nymagee, a dam wall installed across a creek in 1971 has diverted flows into large spreader banks (1 to 2 metres high and 3 to 5 metres base width) on an adjoining plain. The catchment above the dam is about 40,000 hectares, so that the scheme has had to accommodate very large flows.

Early flows proved too much for the scheme to handle, with sections of the diversion bank carrying flows from the dam to the spreaders being washed out during a major flow event in 1972. The same event eroded the ends of some of the spreader banks and a number of the check banks below gaps, completely washing out some of the latter. 

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Despite this significant damage to the “Yaroma” scheme, it has continued to flood irrigate the land beside the stream, albeit less effectively than was intended. Stemming from its operation, two useful design features have emerged for coping with large flows - the large size of the spreader banks and channels, and the outlet design for the diversion bank.

While the size of the diversion bank was not sufficient to prevent its breaching, similar damage has not been sustained by the equally large spreader banks or their channels, which have now withstood numerous substantial flows over a 15-year period.

Apart from this size consideration, the manner in which flows have been led into the spreader banks may have helped them weather large flows. The diversion bank does not lead through a changeover point into the spreader banks, as is the normal approach. Instead it is simply terminated in the paddock upslope of the first line of spreaders, finishing in an extended open sill. Water diverted by the bank thus discharges over the ground before flowing downslope to be picked up by the spreaders. If instead it had been channelled through a changeover point directly into a spreader line, severe scouring would have occurred through the changeover and the receiving end of the spreader line may have been washed away.

By comparison with the “Nullawarra” and “Yaroma” schemes, a 17 year-old spreader scheme at “Cooneybar”, near Byrock, and a 4 year-old scheme at “Florida”, near Canbelego, have operated effectively since installation. Both receive runoff from smaller local catchments than the “Nullawarra” and “Yaroma” schemes. Some of this runoff is harvested from adjacent bare ridges and the remainder comes from modest catchments upstream of the flats the spreader banks occupy.

These observations suggest that more ambitious waterspreading schemes, aiming to control runoff from catchments which are measured in thousands rather than hundreds of hectares, are inadvisable, unless effective provision can be made for emergency bypassing of flows beyond the capacity of the spreader banks. Such might be achieved, for example, by an emergency spillway on a diversion dam supplying a spreader scheme, or by a low, bread-based spillway segment in a diversion bank which carries runoff to a spreader system.

Schemes which may be at risk from occasional major flows might also benefit from an approach adopted in a recent extension to the “Cooneybar” scheme. Broad-base banks with a 5 metre wide spreader channel have been installed (figure 2). These will accommodate occasional major flows with less chance of breaching or scouring than the conventional peaked banks with their narrower spreader channels.

1.3.2 Spreaders on Cultivated Land

Experience on cropping country in western New South Wales indicates that flows discharging from spreader banks more commonly cause soil scour and rilling downslope when the area is under crop or cultivation rather than being stabilised with pasture cover. The problem is most pronounced on gravelly and sandy soils.
A scheme inspected at “Stansfield”, near Tottenham, receives flows coming down 2 gullies from a 300 ha catchment and spreads this water over 350 ha of pasture and cropping land. After 15 years of operation this scheme has caused no significant erosion on the permanent pastures which occupy the upper half of the spread area and thus receive the brunt of incoming flows. In the cropping paddock which comprises the lower half, serious sheet and gully erosion which dissected the paddock prior to treatment has been largely corrected, but some of this erosion has since re-emerged where localised concentrations of discharge have occurred along spreader sills.
The "Stansfield" scheme reflects wider experience which has led to the use of spreaders on cropping country now being approached with caution, and grade banks and waterways often being used in preference. Whether with adequate maintenance spreaders might still offer a preferred approach to grade banks on cropping country is arguable. Certainly their application seems unwise either on highly erodible soils or on slopes above 3% when these are under regular cultivation. There is greater latitude, however, for safe use of spreaders on country which is under permanent pasture or is infrequently cropped.

1.3.3 Maintenance

All soil conservation structural works require some maintenance to continue operating effectively. Waterspreading banks are no exception. Indeed it is arguable that they might require more maintenance than grade, level or absorption banks. This appears to be the case in their early years of operation, or where they are located on land which is regularly cultivated.
In the early stages of operation of a spreader bank, water discharging from it may find a low spot in the sill (figure 3). Discharge will then be concentrated through this point, leading to rilling downslope. Sanbagging or shovelling soil into the low spot will usually correct such minor breaches. A front blade on a tractor may be required to push large quantities of soil, if the break has been allowed to enlarge for lack of earlier attention.

Figure 3: Stock pad across a spreader creating a low spot in the sill (arrowed).

Localised concentrations of discharge can also occur as a result of sediment build-up or plant growth blocking a spreader channel, thereby diverting flows across the adjacent sill. This can occur in both new and established banks. It is avoided by grading the channel when significant vegetation or sediment build-up is evident.

Such grading may be necessary within a couple of years of initial bank construction on cultivation country. Thereafter less frequent grading should prove sufficient, while on pasture country it could be many years before channel cleaning is required.

Scouring can be a problem in gaps and in the changeover section of diversion spreader channels, and the sediment removed can lead to channel blockage as mentioned above. Scour through gaps is affected by their width, their frequency of placement and the shaping of the ground surface. Thus flow velocity - and therefore scour - can be
reduced by increasing the frequency or width of gaps, while a graded fall through a gap into a spreader channel is less erodible than the sharp drop of 15-20 cm which is left when a spreader channel is formed. For the changeover point in a diversion spreader, channel widening may alleviate scour problems by reducing flow velocities.

Scouring can also be reduced by planting grasses such as couch in gaps and changeover points or along sills. With respect to sills, whether or not grass cover is introduced, it is important that a strip at least one metre wide is left undisturbed below them to reduce the potential for erosion by discharging water.

Examination of older spreaders bears out that the least scour is found where stabilising cover has been maintained in gaps and channels and along sills (figure 4). At “Cooneybar”, the bank, channel and sill in best condition after 20 years' operation are in a section which has been isolated from grazing or cultivation by double fencing and has been stabilised by establishment of couch in the gap and along the spreader sill.
The significance of maintenance to continued successful operation of spreader schemes is reflected at “Stansfield” (Section 1.3.2). Here the landholder has sustained an active interest in the operation of his waterspreading scheme over the past 15 years and has carried out maintenance as problems have appeared. While some erosion which might be corrected is evident in the cropping paddock, in general this 350 ha scheme has continued to function effectively during this 15-year period.

1.3.4 General Design Features

Aside from the three salient factors mentioned at the start of Section 1.3, a number of lesser shortcomings evident in the historical operation of spreaders suggest avenues for design modification in certain situations.

Channel Grade

A frequent problem is the failure of diversion spreaders to discharge water along the full length of the spreader sill, even when there are no channel blockages or low spots contributing to the problem. Discharge tends to occur principally over the section of sill
closest to the changeover point (i.e. the end receiving diverted flows). On long spreader sections in particular, only minor amounts may travel to the far end of the sill before overflowing.

A possible improvement might be to survey the spreader channel on a continuing slight grade - say 0.1% or less - towards its extremity, to encourage flows to continue moving along the channel to the end. Such approach has been adopted in the past on some major diversion spreader schemes, where large volumes of runoff were diverted to spread on a wide front. Its application may also be warranted for lesser diversions and for shorter spreader sections.

Another design approach advocated in earlier work is to have a sharp grade immediately past the changeover point (0.5%), gradually reducing this over 50 to 100 metres until the level spreader section is reached. This gets flows moving rapidly away from the changeover point towards the spreader section. It does, however, increase the risk of channel scour.

Bends

Spreader and diversion bank failures may occur at sharp bends where, in an effort to follow the contour faithfully, such directional change has proved necessary. It may be better to sacrifice rigid adherence to selected grades or a level line and accept minor variations, if this can prevent such sharp changes in bank direction.

In the case of diversion~ banks crossing depressions, rather than try to maintain grade by taking the bank in a narrow V up the two sides to an apex in the centre of the depression, it is better to go straight across and simply build the bank higher to compensate for the lower base elevation through the depression.

Gap Location

A certain amount of flexibility is desirable in selecting gap location, rather than sticking rigidly to set intervals. Thus, if a bank crosses a rill line or minor drainage depression, this may be an appropriate location for a gap, to avoid the likelihood of preferred discharge over the sill at this low point in the terrain. Similarly, if a sharp change in bank direction is unavoidable, a gap might be placed at the point of change in direction, thereby avoiding a weak spot in the bank (figure 5).
1.4 Contour Ditches

While spreader banks play by far the major role in waterspreading schemes in New South Wales, contour ditches have been used for an equal length of time as a supporting measure. They are on the lowest rung of the ladder of structures, serving primarily as a guide to contour cultivation.

Contour ditches are similar to the contour sills used in Western Australia, but are built with a disc plough rather than a road grader. Four to six runs (two to three in each direction) are required: the early runs to form a depression, the later ones to spread the soil removed.

Contour ditches will not substitute for banks when erosion is a significant problem. They do, however, perform a useful role as a simple and inexpensive guideline for contour cultivation. They may be used to split slopes between widely spaced banks, or in situations where erosion is not sufficient to warrant banks but contour cultivation is nonetheless warranted for the improved runoff retention it provides.

With minimal maintenance - an occasional cleaning run with a disc plough
- contour ditches can last indefinitely, as evidenced by ditches 15 to 20 years old observed on properties near Fifield and Tottenham (figure 6).

Figure 6: A 20 year-old ditch, still clearly defined and serving as a guide for contour cultivation.

1.5 **Waterspreading in Western Australia**

Two significant factors qualify any consideration of waterspreading potential in Western Australia compared with New South Wales. On the one hand, the sandy nature of many wheatbelt soils may predispose them to the erosion which has proved problematic on more erodible soils in western New South Wales (Section 1.3.2). Countering this, however, is the lower intensity of rainfall events in the Western Australian wheatbelt and the consequent lower erosivity of rainfall and runoff compared with that in western New South Wales.

Balancing one consideration against the other, water erosion seems to be more serious in western New South Wales than in the Western Australian wheatbelt, so the erosion problems associated with waterspreading banks should not preclude their trial in Western Australia. As in New South Wales their potential application is seen in two different situations -the wheatbelt and the pastoral zone.
1.5.1 Wheatbelt

Spreader Banks

Here waterspreading banks might be considered as an alternative to grade and level banks on the long, gentle slopes which are so widespread in the wheatbelt. Their advantage compared with conventional banks would be the elimination of any need for waterways (which are now frequently omitted or of unsatisfactory design) and their potential to increase the availability of water for plant growth.

A number of questions must be answered, however, before any widespread use is contemplated:

Whether on sandy soils sills will maintain their definition under the pressure of stock trampling and wind erosion.

Whether erosion downslope from the spreader sill will be a significant problem, particularly with regular cropping.

Whether on duplex soils subject to waterlogging spreader banks will aggravate or dissipate this problem.

These questions are being addressed by trials installed during 1985 and 1986 at Darkan, Wyalkatchem and Buntine.

The Darkan trial is examining alternative soil conservation structures in country where heavy summer rains have historically caused breaching and overtopping of conventional level and grade banks. A catchment on the property of Ian Woodruff has been treated with a series of diversion and gap spreader banks (figures -7 and 8). These are intercepting flows down a gully line and discharging them onto adjacent ridges. The approach is being compared with alternative treatments on two adjoining catchments, one using gully checks with level sill outlets and the other using absorption banks.

At Wyalkatchem a one kilometre bank line, incorporating diversion and gap spreader components has been installed on a gently sloping crop paddock on the property of Brian Trenorden. This is a situation where grade banks are commonly used at present.

At Buntine diversion, gap and gap absorption spreader banks have been installed on the property of Bevan Shaw. These are part of an NSCP project to assess broad based and spreader banks as alternatives to conventional level and grade banks for coping with runoff from intense summer thunderstorms on the long, gentle slopes of the northern wheatbelt.
Figures 7 & 8: Sections of a spreader bank trial installed at Darkan in 1986. Changeover point (above) and end of spreader with check bank (below).
Bulldozers were used to construct portion of the banks at Darkan and Wyalkatchem, but otherwise all construction has been by road grader. While the banks thus built are not as substantial as the equivalent dozer-built structures used in N.S.W., they appear adequate for the task and are cheaper ($300 to $400 per kilometre). Nonetheless, they will have to be evaluated over time, to see whether excessive settlement of the sandy soils from which they are constructed justifies the use of bulldozers to obtain a larger bank.

Contour Ditches

In light of New South Wales experience with contour ditches, grader-built sills or plough-built contour ditches may be worthy of wider use in the W.A. Wheatbelt. Their use to provide a guide for contour cultivation, to control minor erosion and to improve runoff retention may be a cheap alternative to construction of banks in low hazard situations. They could thereby provide a basis for more widespread adoption of contour farming, when landholders are otherwise reluctant to incur the expense of contractor-built banks.

1.5.2 Pastoral Zone

In the pastoral zone waterspreading schemes might be contemplated similar to those developed in the Cobar-Byrock region of New South Wales. The objective would be to provide areas of up to several hundred hectares where runoff harvested from an external catchment would be spread onto introduced pastures or fodder crops.

The approach would require permission for clearing and cultivation, as it is axiomatic with such schemes that the receiving area is cleared and sown if full benefits are to be derived. The primary result may otherwise simply be promotion of more dense and vigorous native scrub.

Based on New South Wales experience, if such approach is pursued, it would seem desirable to select areas with stable soils and slope gradients less than 1%, and not to be over-ambitious in harvesting large volumes of runoff.
2. Waterponding

Waterponding has been in use for the past 20 years in western New South Wales as a technique for reclaiming scalded soils. Its introduction saw earlier techniques of complete ploughing, pitting, and contour, spiral and checkerboard furrowing largely superseded on scald areas because its success was more marked and consistent.

Waterponding provided complete plant cover over treated areas, whereas the various cultivating and furrowing techniques generally saw plant establishment only in the furrows. Furthermore, unless a ponding bank failed, its effect was permanent, whereas furrows often slaked down and the surface had to be reworked after a few years to sustain an effect (Figures 9, 10, 11 and 12).

Yield assessment from ponded areas has shown them to be an attractive proposition from a financial standpoint. In a 450 mm annual rainfall regime at Nyngan, a centre where much scald reclamation is occurring, a 5-year study showed that a ponded scald produced sufficient feed to carry 3 dry sheep per hectare, compared with negligible production prior to treatment (Cunningham et al., 1974). With bank construction costs currently ranging from $10 to $15 per hectare, such improved carrying capacity can recoup treatment costs in one year’s production.

2.1 Surveying

With these excellent results, there has over the years been an increasing demand from landholders in western New South Wales for waterponding on scalded soils. In response to this demand the NSW Soil Conservation Service has developed a mobile laser level which is based at Nyngan and is employed specifically for ponding bank survey. A technician is engaged full-time operating this equipment.

The mobile laser is similar to that used by the WADA for grade and level bank survey in the wheatbelt a stationary transmitter operates off a 12 volt battery, with a receiver mounted on a 4WD utility. Instrumentation inside the utility provides a digital readout of ground elevation and distance travelled. A tyne mounted on the rear of the vehicle can be raised and lowered from the cab to mark the surveyed bank line.

When surveying ponding banks with this equipment, the operator works in increments of up to 100 hectares. Having selected an area for treatment, he surveys a grid over this area in the evening, when laser reception is not hampered by heat haze and its range is thus at a maximum.

The operator drives parallel lines 100 metres apart and 1 kilometre long, recording spot heights every 100 metres. A trip metre which measures 10-metre increments and a compass for ensuring successive runs are parallel facilitates accurate survey of the grid.

With 100 spot heights obtained in this manner, a contour plan is prepared. This provides a good indication of the alignment banks will follow over the area. The following day,
using the contour plan for guidance, bank lines can be surveyed and marked in a single pass of the survey vehicle. They are spaced at vertical intervals of 10 centimetres, with each bank 200 to 300 metres long and turned up at each end to pond a maximum 10 centimetres depth of water. Openings are left between successive banks to allow access for mustering, as well as for random movement of sheep through treated areas.

Figures 9 & 10: Chisel ploughing (above) and pitting (below) up to 20 years old on scalds north of Nyngan. Plant growth within the furrows ranges from poor to good, but there has been no colonisation between furrows.
Figure 11: 20 year-old checkerboard furrowing in the same area as Figures 10 & 11. The same shortcomings in plant response are evident.
Figure 12: By contrast with the cultural treatments in figures 9, 10 and 11, this pond in the same locality is showing an impressive response, with near total cover only 8 months after installation.

For quicker survey, it may be practical for the survey vehicle to simply mark out contours on the ground at 10 centimetre vertical intervals without separating individual banks by marking the turn-ups of their ends. It would then be left to the grader operator building the banks to provide turn-ups at 300 metre intervals, leaving the marked contour he is following and cutting uphill until he is within, say, 5 to 10 metres of the next marked contour upslope. For the next bank he would then cut downhill from the same level until he returned to the original contour, follow this for 200 to 300 metres, turn up again, and so on (figure 13).
Using the laser and the grid survey approach outlined above, the Soil Conservation Service has increased its rate of bank layout 10-fold per unit of labour input. One man can now survey about 40 hectares per day, where it previously required 3 men (one on the level, one on the staff and one on a tractor marking the line) to survey 12 hectares per day.

### 2.2 Construction

A range of construction equipment has been tried for building ponding banks: one-way discs, opposed discs, trailed graders, front blade on a tractor, and road graders. The last appears to be the most cost-effective implement, and it is difficult to perceive anything presently available replacing it. Cheaper implements such as one-way discs build banks which are too small and are more prone to failure, while larger banks have been obtained with the trailed grader and with a massive opposed disc machine, but at a cost exceeding that of banks built by road graders.
A bank 40 centimetres high (which settles to 30 centimetres) is sought, and this is generally obtained with 2 to 3 cuts by a road grader. The soil is cut from both sides on successive runs, with the blade set for maximum width - and thus minimum depth - of cut.

### 2.3 Pond Area

The maximum recommended storage behind a single ponding bank is a half hectare, and the bank length of 200 to 300 metres is tied to this recommendation. Trials of banks longer than 300 metres are, however, planned.

Earth baffles (single cut banks) will be installed at regular intervals across the storage area enclosed by these longer banks. These baffles will break up wave action - a major factor in bank breaching. A gap will be left between the end of each baffle and the holding bank, as experience has shown that an acute or right angle join between banks forms a weak spot where wave action is accentuated and breaching is more likely. A shortcoming, of course, is that failure in the holding bank will see loss of a larger ponded area than would occur if the baffles joined the main bank to provide a series of separated storage areas.

Some longer banks were observed in existing treatments at Marra Creek, north of Nyngan. These encompassed areas of up to 2 hectares. They were evidently working successfully and had not been breached, suggesting that larger pondages may be a safe option anyway, with or without earth baffles.

### 2.4 Pasture Improvement

Limited work on the introduction of improved pastures ‘behind ponding banks has demonstrated little value for the cost of this work compared with allowing natural colonisation by pastures from surrounding areas. Annuals and perennials endemic to the locality have established rapidly on ponded areas and, in earlier trials, have replaced improved pasture species which were seeded into ponds when they were first installed.

Further work is nonetheless proposed to examine certain native species (notably *Atriplex*) for their potential to improve pasture regrowth on ponded areas.

### 2.5 Stock Management

Ponded areas are not necessarily destocked, but it is important that grazing is managed to ensure that regrowth of perennials, in particular, is not removed as fast as it establishes. It is generally preferred to hold stock numbers to pre-treatment levels until regrowth in ponds is well established.

Aside from pasture production, an advantage which has been observed with some ponding schemes is that when the banks are storing runoff they provide dispersed watering points for livestock, thereby reducing pressure around permanent water points.
2.6 Waterponding in Western Australia

There are vast areas of gently sloping scalds in pastoral areas of Western Australia which may respond to waterponding. Claypan-like remnants of eroded duplex soils are most likely to benefit, but the deep clays of the Fitzroy frontage, where pastures have been degraded by overgrazing, and sheet eroded hard red soils in the Goldfields, Murchison and Pilbara may show a positive, if slower, response.

2.6.1 Pilot Schemes

Pilot areas of waterponding have been installed during 1985-86 at a number of locations in the W.A. Pastoral Zone, embracing a range of climatic regimes and soil types. These are discussed briefly below.

Leonora

At Leonora, ponding banks were installed in May, 1985, over about 70 hectares on “Sturt Meadows” Station. They are on watersheeted hard red soils which shed water rapidly, support negligible growth and have surface gradients of up to 0.4%.

There is some uncertainty about the likely effectiveness of waterponding on these hard soils. However, after 25 mm of rain in June, 1985, filled most ponds, promising germination and growth response (notably Sclerolaena) was seen. The response was best in those ponds which had a veneer of softer colluvial material on the surface and which were in the path of extra runoff overflowing from a drainage line through the area. Response on hard, watersheeted areas which lacked this softer veneer was disappointing.

A major flow down this same drainage line in March, 1986, breached a large number of the banks in the system. It is uncertain whether the damage was simply due to excessive flows overtopping the banks, or whether contributing factors were soil dispersibility and consequent tunnel erosion in them and/or their failure to key into the smooth, hardened underlying soil. In respect of this last point, there may be merit on such hard surfaces in pre-ripping the ground where the bank is to sit, to allow it to key effectively into the underlying surface.

A further area was treated on “Sturt Meadows” in February, 1986. This is on eroded duplex soils and early results are indicating a problem of severe slaking of the banks, possibly reflecting high sodicity.

Carnarvon

At Carnarvon ponds were installed during April, 1986, on over 100 hectares of extensive eroded duplex scald, with slopes below 0.3%, on “Wooramel” and “Boolathana” Stations. Of all the sites treated thus far, these have soil characteristics such that the best response to ponding might be anticipated.
A 12 ha enclosure has been fenced at “Wooramel” within which soil and vegetation monitoring are to be conducted over a minimum of 2 years to compare the effectiveness of various reclamation treatments, including waterponding.

**Karratha**

On “Karratha” Station, ponding banks were installed over about 100 hectares at several widely scattered locations during November, 1985. The scalds treated are on eroded texture contrast soils, cracking clays, and some watersheeted hard red soils like those treated at Leonora. Slope gradients range up to 0.3%, with most treated scalds being on gentle rises adjacent to vegetated run-on areas or creek lines.

The Station Manager advised that the ponds filled during February-March, 1986, when 150 mm of steady rain were received over a period of several weeks. All the banks held and there was a subsequent growth response, particularly on one area of eroded duplex scald and on the cracking clays.

Subsequent to this ponding event, cattle got amongst some of the banks and substantially damaged them by pawing and rolling on the dirt, to the extent that re-building of damaged sections proved necessary. Exclusion of cattle may be necessary until plant regeneration is achieved, if this proves a recurring problem.

**Kimberley**

Along the Fitzroy River frontage ponds were installed during the winter of 1985 on “Meda”, “Qianbun Downs”, “Go Go”, “Myroodah”, “Brooking Springs”, “Cherrabun” and “Jubilee Downs”. Some were also installed on “Fox River” Station in the East Kimberley.

The Fitzroy frontage ponds are largely on floodplain clay soils where past overgrazing has seen most of the perennial pasture species disappear. A degraded cover of annuals (notably ricegrass) and, in some cases, bare scald now remains.

Unfortunately the Fitzroy floodplain lived up to its name in January, 1986, when Cyclone Hector put up to 2 1/2 metres of water over the treated areas. This is a risk which must be faced on such floodplain areas. Acceptability of such risk will have to be measured in the future against the ultimate results achieved with the ponds.

The flood substantially eroded and breached the banks, demanding total reconstruction. Sufficient evidence of them was, however, left to ensure that resurvey is not required to permit their rebuilding.

A couple of the “Cherrabun” banks survived the flood event and ponded water after the flood receded. While plant cover in these is not impressive at present, it includes a wider variety of annuals than occur on adjacent untreated areas. The success or otherwise of the technique in this particular environment may hinge on how rapidly these various
species spread within the ponds in future seasons, and their feed value compared with the annuals which prevail on untreated areas.

### 2.6.2 Construction Technique and Cost

Apart from some work with opposed discs and a rear-mounted tractor blade on the Fitzroy frontage, the ponding banks thus far built in Western Australia have been constructed by road grader. Based on grader performance, it is difficult to perceive any other implement being more cost-effective, banks of adequate dimension being obtained with two or three passes of the grader.

The area enclosed within individual ponds has generally been larger than the 1/2 hectare maximum recommended in New South Wales, probably averaging closer to one hectare. Within some ponds larger than one hectare, a single cut divider bank has been installed to reduce fetch and thus the wave action which can cause bank breaching.

With the above approach to pond size and construction, costs have been in the vicinity of $10 per hectare. At all sites treated, if the ponds prove successful in restoring original levels of vegetative production, such an investment should see a minimum return of 10% per annum.

### 2.6.3 Evaluation

As well as testing waterponding per se, the local trials will allow comparison of the technique with other treatments currently used to encourage regeneration in the pastoral zone (notably pitting). The relative costs, the speed and degree of regeneration, and the need or otherwise of repeat treatments can be compared.

New South Wales experience suggests ponding may prove superior to other treatment’s on scalded duplex soils, but the efficacy of the technique on the deep clays of the Fitzroy frontage and on sheet eroded hard red soils is less certain. On steeper country (generally gradients above 0.3%), pitting or furrowing is likely to be a preferred approach, as the closer ponding bank spacing required on such slopes raises costs and interferes with paddock movement to an unacceptable degree.

Whatever benefits ponding may eventually prove to offer, plant response will likely be slower in this State than the rapid responses seen in New South Wales. Waterponding in the latter State has been concentrated in the 350 to 450 mm rainfall zone, a higher rainfall environment than most of the pilot scheme locations in 2.6.1 above. The possible exceptions to this are the various Kimberley locations, but they are in a summer-dominant rainfall region where high summer evaporation may offset any benefit from higher incident rainfall.

Depending on seasonal conditions, it is therefore conceivable that several years’ monitoring may be required before firm conclusions are drawn from the various waterponding schemes now in place in the W.A. Pastoral Zone.
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Further Reading


