IRRIGATION Salinity FACTS

Number 3 October 2000 ISSN 1 326–5350

Draining & Reusing Irrigation Water

Good irrigation management can be divided up into two parts: getting water on when it is needed, and then getting the excess water off the paddock as quickly as possible.

Better irrigation management leads to higher productivity, both in the short and the long term; and reduced environmental impact.

Crops and pastures will benefit from less moisture stress, the result of appropriate irrigation supply and scheduling (*'Right Amount, Right Time'*) and reduced waterlogging (due to improved drainage).

In the longer term, water and pumping costs can be lowered, waterlogging and salinity problems minimised and watertables controlled.

Waterlogging

A well structured soil has spaces containing water and air—both necessary for plant survival and growth (refer to Irrigation Salinity Facts: *Principles of Surface Irrigation)*. A soil at field capacity still contains a significant number of air-filled voids. In a waterlogged soil the spaces in between the soil particles are filled with water, so plant roots have no access to oxygen.

Salt Action

Community and government working together to manage salinity in NSW

Different plants react to this in different ways. Most agricultural plants (except rice) suffer as oxygen and nutrient uptake through the roots slows. Rushes, docks and sedges thrive and will out-compete more desirable species. In addition, beneficial soil microbes are destroyed, plant and animal diseases spread, and machinery and livestock damage the weakened soil structure.

"A drainage reuse system will increase water available to the farm by 10-25%"

Research has shown that summer pasture growth is reduced after only six hours of water ponding, and that water regularly lying on perennial pastures (white clover and ryegrass or paspalum) for 24–48 hours will reduce growth by 25% over an irrigation season, and lower the clover content. Rice is the exception, as it is naturally an aquatic plant, so it tolerates waterlogging.

Soil will remain waterlogged until the excess water is removed by plant use, evaporation or drainage. If ponded water remains on the soil surface, some will drain down through the soil profile, adding to the local watertable. This seepage can cause rising watertables and soil salinity, leading to environmental damage and production losses.

Effects of waterlogging

- nutrient uptake stops and the roots die
- plants have no energy for growth
- beneficial soil microbes die
- machinery and livestock can damage soil structure
- plant and animal diseases occur
- water-loving weeds like rushes, dock and sedge thrive
- pastures can be scalded by standing water heating up on a hot day
- some nutrients (especially nitrogen) are leached down through the profile below the roots, where they are not used

Waterlogging becomes an even greater problem in areas with shallow watertables. Soils that become waterlogged following rainfall or irrigation will stay saturated for longer periods because there is less opportunity for downward seepage and flushing of salts.

Rainfall is the major cause of waterlogging in the cooler months of the year, while poor irrigation is the major contributor to waterlogging in spring, summer and autumn.

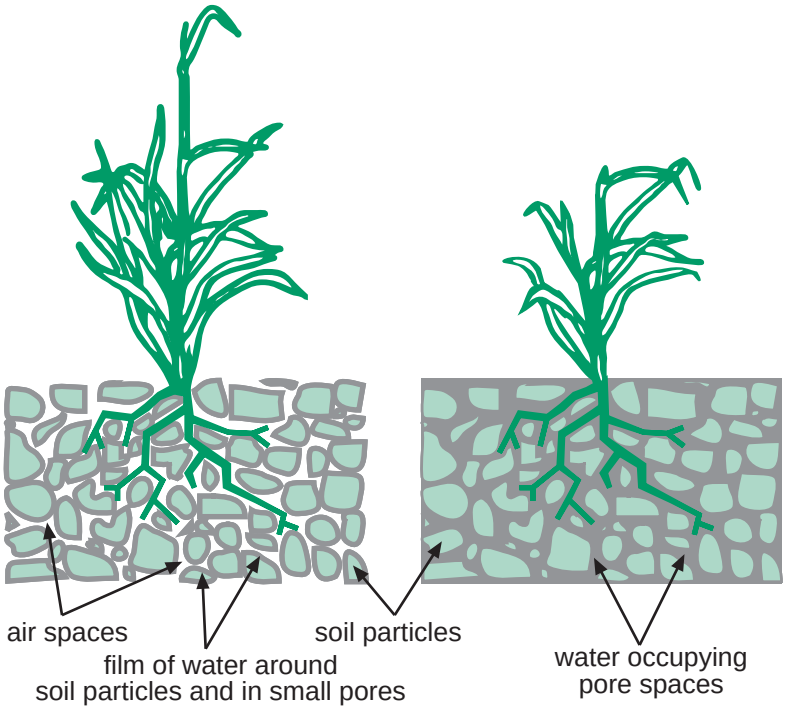

Figure 1: A well-structured soil has both air- and water-filled spaces (pores) in the profile (left). In a waterlogged soil (right) the pores are filled with water, depriving the roots of oxygen and slowing nutrient uptake and plant growth.

What can be done to avoid these problems?

The key to improving irrigation efficiency (and reducing waterlogging) is to improve paddock surface drainage.

Reusing this drainage water will help to improve overall irrigation efficiency.

Paddocks can be drained by surface or sub-surface systems.

Surface drainage

Good surface drainage will only be achieved by having a layout with adequate slopes, suitable bay lengths and a drainage system to remove runoff water from the bottom of the paddock as quickly as possible (see Irrigation Salinity Facts 2: *Principles of Surface Irrigation*).

The drains should be able to take surplus water away from every paddock on the property. All paddocks should be drained quickly, preferably within 24 hours. This will minimise waterlogging losses and reduce the amount of water seeping through to the watertable.

Poor surface drainage is usually more obvious on heavier soils. These soils tend to be flatter, as well as having poorer internal drainage (i.e. drainage down through the soil). The effects of poor drainage are less obvious on lighter soils because excess water can soak away if the watertable is deep enough. Efficient drainage of these lighter soils is very important in preventing rising watertables.

Improving surface drainage

Techniques that can be used to improve surface drainage include:

- making the slopes of paddocks steeper than 1:800 so that water is less likely to lie on the paddock.
- making bays shorter so that water spends less time draining from the top of the bay to the bottom.
- keeping drains and toe-furrows clean and well-maintained at all times to make sure that water flows away quickly. This can be achieved by making drains that are self-draining, and cleaning toe-furrows if they are filled in at harvest time. Ponded water will encourage aquatic weed growth, which slows down the flow of water, lowering head and increasing recharge.
- using a rotary drainer to make spinner cuts from the waterlogged or low-lying areas to the drain at the bottom of the paddock. This may be necessary on paddocks that have not been laser-levelled or are flatter than 1:800 (and should be incorporated down the centre all bays with slopes flatter than 1:1200). Spinner cuts can also improve drainage on bays with heavy pasture growth.

Benefits of a drainage reuse system

- increase water available on-farm by 10–25%
- improved farm drainage
- greater flexibility in irrigation management
- retention of nutrients & chemicals on-farm

Practices to avoid

There are a number of practices to avoid when draining paddocks:

- drains should not be so deep that they run through sub-surface sand because this will lead to water seeping out of the drain down to the watertable.
- drainage lines should not cut through an existing high watertable because water from the watertable will enter the drain. If the groundwater is saline and drainage is being recycled for irrigation, the quality of irrigation water will be lowered.
- excess irrigation water should not be directed into district drains. This water may contain unacceptable levels of salts, nutrients or chemicals and should be recycled on-farm.
- gravel pits should not be used for drainage disposal. It may appear to be an easy solution in the short term, but gravel and sand pits are invariably part of the local groundwater system.
- paddocks should not be drained onto roadsides or into other ponded areas. This water seeps through to the watertable and can cause severe damage to road foundations, costing shire councils (and ratepayers) large amounts for road maintenance.

"The key to improving irrigation efficiency is good drainage"

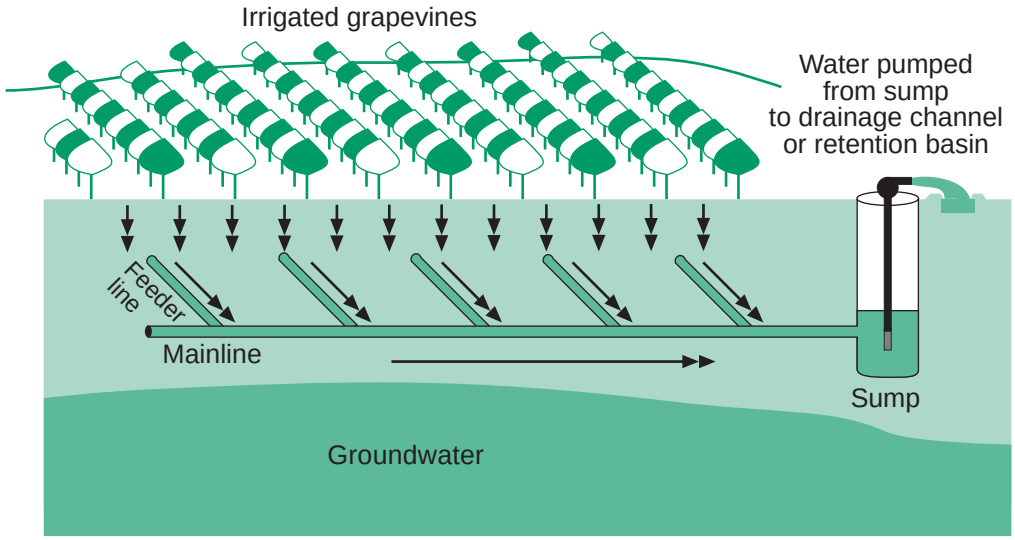

Figure 2: A tile drainage system can intercept deep seepage from high value crops such as grapes.

Sub-surface drainage

Sub-surface drainage involves removing water from the soil after it has passed below the soil surface, and before it reaches the local watertable. Tile or mole drains and groundwater pumps are the most common methods of subsurface drainage.

Tile drainage

Tile drains are networks of small drains (made out of terracotta or plastic pipes) collecting sub-surface water from all over a paddock (Figure 2). These empty into a mainline which leads to a collection sump. From here the water is pumped out to a drainage channel or reuse system.

Tile drainage is only effective where lighter soil types allow good sub-surface water movement. The costs of large scale tile drainage can be very high and it is generally used only in conjunction with high value crops.

Mole drainage

The internal drainage of some soil types may be improved by forming small enclosed channels in the soil at a depth of 50 or 60 cm. This can be done by using a mole drainer.

The effectiveness of this technique depends on the stability of the soil type. Mole drains will collapse quickly if the soil is not suitable. Research carried out by CSIRO at Griffith has shown that mole drainage is a viable management option for controlling waterlogging and salinity in the root zone of irrigated crops on self-mulching grey clays. Refer to Irrigation Salinity Facts: *Using Mole Drainage* for more information.

Groundwater pumping

In some areas it is possible to pump water from highly permeable aquifers (beds of gravel or sand in the soil).

On-farm groundwater pumping usually takes water from shallow aquifers using a spearpoint system.

The effectiveness of groundwater pumping for controlling watertables depends on how much water is pumped, how quickly the aquifer fills up again and the permeability and thickness of the aquifer.

A thick aquifer of coarse sand or gravel will usually mean that the water is drawn from a large area, whereas an aquifer made up of a thinner band of finer sands will usually yield less water and may be less effective in lowering the watertable over a wide area.

The water pumped may be used for irrigation, depending on its salinity (see the Salt Action Information Sheet: *Using Shallow Groundwater for Irrigation*).

Reusing drainage water

Making full use of drainage water is an important part of water management. A good reuse system will capture all paddock runoff, with the ability to store water for later use.

Storing and reusing drainage water and rainfall has a number of advantages:

- Water allocation on the farm can effectively be increased by 10–25%, depending on the standard of irrigation management (through saving water otherwise lost as drainage).
- Reuse gives greater flexibility in the timing of irrigations. Water can be applied to crops and pastures when they need it, rather than having to wait a few days for a water order to be processed, or having to deal with rationed flows at times of peak demand. Also, groups of bays or furrows can all be irrigated and shut off to suit the slowest, without loss of water from the quicker bays.
- Irrigation management is easier and more flexible. If the wheel is turned off before the irrigation is finished, stored water can be used to finish the watering. Likewise, if the watering is finished but the wheel won't be turned off for another half a day, the excess can be stored and reused later.
- Reuse systems can provide greater supply flows so each paddock can be watered faster, depending on farm channel capacities and irrigation layout allow it.
- By keeping drainage water on the farm, the pressure on district drainage schemes will be reduced, particularly after heavy rainfall.
- When draining recently fertilised paddocks, up to 20% of the fertiliser applied can be flushed out with the drainage water. If not recycled back onto paddocks, these nutrients are lost to the farm, costing money. There are also limits for nutrients and chemicals entering local waterways.
- If the farm does not have access to district drainage, mishaps such as rainfall immediately after irrigation can be handled without the farm becoming severely waterlogged.
- A reuse system can be used to irrigate otherwise uncommanded land, with the aid of pumps.
- In rice cropping, the crop can be drained promptly at the right time, and the water reused on a pasture or other crop. This simplifies the critical issue of shut-off of irrigation.

Figures 3 and 4: Poor drainage management wastes water, costing you money and causing seepage through to the watertable.

Principles of a good reuse system

The design and cost-effectiveness of reuse systems varies from farm to farm and from region to region. Still, the following general principles are relevant to most districts:

- Integrate all developments of the irrigation layout so that the farm will work as a complete system. Follow a whole farm plan or IDMP.
- Aim to be able to cope with average rainfall and irrigation runoff at the same time. To achieve this, drains need to be well-designed, having the capacity to handle large flows.
- The system should be simple and reliable to ensure ease of operation and minimise operating costs.
- Drains need to be well maintained and should empty out quickly to minimise weed problems.
- Pump the recycled water as close to the main supply point as possible. This will maximise the area over which the water can be used. This will also make shandying poor quality water easier.
- Bring all drains back to one pumpsite.
- Command as much of the farm as possible.
- The pumpsite should be easily accessed for operation and maintenance.

Design the on-farm drainage recycling system to allow access to the district drainage scheme, if available. During heavy rainfall, runoff from landformed country occurs very quickly. If the on-farm system can't handle the water then district drainage can be used to dispose of the excess water, if more than 12.5mm of rain has fallen in that rainfall event.

Figure 5:
A farm storage built as part of a reuse system allows drainage water to be recycled for later use.

Quality of Recycled Water

The salinity of drainage water can vary depending on the salinity of the soil and the quality of the irrigation water. If the water from sub-surface drainage is of acceptable quality, it can be reused for irrigation. If not, disposal of this water can be a major problem. However, by recycling water and managing drainage quantities; smaller volumes of saline drainage water will be produced, and so little will need to be disposed of.

Be careful when irrigating saline soil and reusing the excess water: the drainage water will have dissolved some salts from the paddock.

Regularly monitor the quality of reuse water to make sure it does not reach a level which will damage crops and pastures. If salinity levels are above 0.8 dS/m, consider shandying the recycled water with channel water (see Salinity Note 7: *Water Salinity Guidelines*). Hand-held salinity meters are available to quickly test water on-farm and should always be used to test drainage water before it is reused.

When reusing drainage water be careful not to damage one crop with the chemicals from another. For example, drainage from a maize crop that has been treated with Atrazine® should not be reused on soybeans because the water may be contaminated with the herbicide which will damage the sensitive soybeans.

This may necessitate careful design of the supply and recycling systems so contaminated water can be diverted away from sensitive crops such as rice.

Due to the draining of chemicals and salts into the reuse system, the storage should not be used as a supply for domestic use.

Building a Drainage and Reuse System

Planning

Good on-farm water management requires farm drains at the end of every bay collecting water to a central point, an outlet to district drains and a facility to allow the storage and reuse of irrigation and rainfall runoff.

Planning is best done on a whole farm basis, so the layout is integrated and efficient. Remember planning on paper is less costly than moving dirt.

Your reuse system should:

- recycle water over as great an area of the farm as is economically possible to maximise flexibility. Seasonal drainage should be able to be used on same season crops and pastures.
- be able to cope with all irrigation runoff, and the first 12.5mm of rainfall.
- be simple and reliable to make sure that it is easy to operate.
- be designed to drain out well to minimise weed problems.
- be capable of handling storm runoff flows, which often exceed irrigation drainage flows.

Direct the recycled water to as close to the wheel as possible. This will maximise the flexibility of the system because you will be able to use your recycled water everywhere channel water is used. It will also make shandying slightly saline water easier (see Salinity Note 7: *Water Salinity Guidelines*).

Ideally the whole property should be commanded to give maximum flexibility. However, some areas may have to be left out because it is uneconomic to command them.

Equipping the system

Storage

The storage should be large enough to hold all the drainage water from each irrigation and from unexpected rainfall. It is preferable to collect water by gravity rather than having to pump it into storages. The more storage available within the drainage lines the more flexible the system will be.

Recycling dams must be placed on suitable soils (sufficient depth of clay beneath them) to minimise loss of stored water through the dam bed into the groundwater.

Points to be considered when working out the volume required for storage:

- What is the size of the area that will be irrigated with this water?
- How much water is to be applied?
- Is the water to be harvested run-off only, or from other sources, such as creeks, neighbours or roadsides?
- Is it possible to put overflow into the regional drainage system?
- Does it meet the requirements of the EPA and irrigation authorities?

For more information, refer to Irrigation Salinity Facts 5: *On-farm Storages* and the *WaterWise* publications.

Pumps

A reuse system will need to include a way of getting the water back into the irrigation system. This involves using a pump of some sort.

Usually the most economic pump site is some point between the supply channel and drainage channel. If a storage dam is included in the reuse system the pump should be located at the storage site. The pump site should be easily accessible, making it more convenient to use and maintain.

Comparison of power supplies for reuse system pumps

Diesel

Advantages
- Can be located anywhere
- Flow rates can be easily altered

Disadvantages
- High cost to purchase
- High maintenance requirement
- Short life
- Transmission costs can be expensive for higher horse power

Electric

Advantages
- Cheaper to purchase pump
- Reliable
- Long life
- Easy to automate

Disadvantages
- Very high cost involved in getting power to site
- Fixed flow rates

The pump and power unit should be selected to be as efficient as possible for the task required. This will significantly reduce operating costs. Poorly selected or mismatched equipment can double or even triple the cost of recycling your irrigation water. A less efficient pump may require a much larger and more expensive power unit.

The type of power unit used to drive the pump (electric or diesel) depends on individual circumstances. Some advantages and disadvantages of different pumps are detailed above. For more information, see Irrigation Salinity Facts: *Reuse Pump Systems*.

This information has been produced as part of Salt Action, the community and government initiative for managing salinity in NSW.

Authors:
Richard Swinton, NSW Agriculture, Grafton
Simon Gibbs, Salt Action, NSW Agriculture, Forbes
Allan Grogan, Works Publishing, Exmouth

Design, editing, artwork and layout:
Simon Gibbs, Salt Action, NSW Agriculture, Forbes

With thanks to:
David Rosenbaum, formerly NSW Agriculture, Deniliquin
Chris Rolfe, NSW Agriculture, Wollongbar

For more information, contact your local Irrigation Officer or Salinity Officer at NSW Agriculture:

Condobolin (02) 6895 1007
Dareton (03) 5027 4409
Deniliquin (03) 5881 9999
Forbes (02) 6850 2922
Griffith (02) 6960 1300
Yanco (02) 6951 2611
Macquarie Valley Landcare, Trangie (02) 6888 7778

Salt Action

LAND & WATER CONSERVATION

NSW Agriculture

TCM

Total Catchment Management
Community And Government Working Together

Printed on recycled paper by ActivePrint