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Effects of surface drainage on dryland salinity

By P. R. George, Soil Research and Survey Branch and T. R. Negus, Officer in Charge, Narrogin Office.

Areas which are salt-affected are often also flooded. Although flooding is not the basic cause of salinity, surface drainage may improve conditions for plant growth, and this article describes suitable methods.

Surface drainage is used to prevent or reduce flooding problems. It is rarely, if ever, claimed that surface drainage alone will control soil salinity, although under certain conditions it is used in other parts of the world with sub-surface drainage to give better control of watertables (see article "The dryland salinity problem in North America").

Surface drainage may be useful where:
- The topography is extremely flat and the soils are relatively impermeable.
- There are depressions that hold water.
- Large amounts of runoff from surrounding higher land accumulate.
- Overflow from streams or rivers is likely.
- The natural drainage lines are ill-defined or discontinuous.

In agricultural districts, flood-prone areas are also mainly those where salinity occurs. This may be a cause of the belief that flooding is a major cause of soil salinity. However this oversimplifies the cause of salinity. Other articles in this Journal explain the importance of subsoil sources of salt which are brought to the surface by capillary rise from shallow watertables.

Because of the association between salinity and flooding, surface drainage is commonly used to reduce flooding, and hopefully salinity also. It reduces water-logging and thus improves conditions for plant growth. This allows maintenance of good plant cover which protects the soil surface and can reduce the rise of salts to the surface. The value of ground

Fig. 1.—Profile of W-drain

Fig. 2.—Levee which does contain the water but has not stopped the spread of salt

Fig. 3.—Interceptor bank
cover in reducing the rise of salt to the surface from the watertable cannot be over-emphasised. Surface drainage practices have largely developed out of experience and observation. No controlled studies have been done on the effectiveness of the various drainage schemes in the wheatbelt. This article reports on the main surface drainage techniques used in the wheatbelt and observations of their effectiveness, mainly in relation to soil salinity. For the purpose of this article, surface water is taken also to include shallow, perched groundwater which, on sloping areas, flows laterally along less permeable material such as a layer of clay in the soil profile. Generally this perched water will be within 1 metre of the surface, but this varies. This definition allows discussion of interceptor banks and interceptor drains.

**W-drains**

W-drains are used mainly in flat areas and consist of two closely spaced parallel single drains, the spoil from each being placed between the drains (Fig. 1). The advantage of W-drains is that the spoil does not have to be spread and water from surrounding areas can flow directly into the drains from each side. They are cheap and convenient to construct and work most effectively when the area they are draining is smooth with few irregularities to retain surface water. W-drains are frequently recommended to remove excess surface water from salt-affected land, to provide better conditions for growth and establishment of salt-tolerant vegetation. They do achieve this, but fencing to control grazing on the saltland is still of prime importance. W-drains have not been observed to stop or reverse the spread of saltland. However, on relatively porous soils where they have reduced flooding and hence seepage down to the water table, the area over which the saline watertable comes near to the surface may be reduced. In this situation the drains may have stopped the salt from spreading as far as it would have spread without treatment. Such situations are uncommon in Western Australia.

Spoon drains are a modification of W-drains. A special spinning digger mounted on a tractor is used to dig a shallow drain and thinly spread the spoil over the adjacent land. Unlike W-drains they do not pose a barrier to cultivation and water can be easily led into the drain. Spoon drains can be rapidly installed but require regular maintenance to be effective.

**Levees**

Levees are built along major creeks to prevent water flooding adjacent pastures and crops for extended periods (Fig. 2). Levee systems can be single-sided or double-sided, and to be most effective, adjacent areas outside the levees need supplementary drainage to enable surplus 'local' water to drain into the creek. This usually is not done and waterlogging and flooding from local runoff and tributaries of the main creek occurs. Extremely low gradients in the main channels often make it difficult to provide gravity inlets into the creek but venturi inlets which rely on higher flow velocities in the main drain to suck in this local water have proven effective. Levee systems, if well sited and built, can contain large volumes of water flowing from upper catchment areas. In this way flooding from local water sources and rainfall is not worsened by flood waters from further up the catchment. Levees have not, however, been observed to directly reduce soil salinity.

**Grade banks**

Grade banks (commonly referred to as contour banks) are built on sloping land and are designed to reduce the speed of overland flow of water and lead runoff to safe waterways. This reduces erosion risks. Grade banks and associated contour cultivation encourage the retention and absorption of as much water as possible where it falls. This reduces runoff, and helps prevent flooding and waterlogging of low-lying areas and erosion of sloping areas. Retaining water on the slopes where it falls will reduce the need for drains and levees in low-lying areas.

One case where grade banks have reportedly reduced the area of saltland is on an area of light...
gravelly soil near Narembeen.
Clearing from 1962 to 1967 caused
8 ha of saltland and it is claimed
that grade banks installed after
1967 have been associated with a
reduction in saltland to 0.4 ha.
Similar reports are heard from
farmers in the wetter parts of the
wheatbelt who have contoured their
higher slopes.

Interceptor drains
Interceptor drains are installed to
collect relatively shallow sub-surface
water flow coming from upslope,
and prevent it reaching the area to
be protected. They are suitable
for cutting off and diverting
underground water supply from
seepages on sloping areas if the
seepage is caused by impermeable
rock or clay at shallow depth.
The amount of flow intercepted by
a drain depends on its depth
relative to the thickness of the
waterbearing layer. On steep
slopes open drains are more
effective than covered tube drains,
and an open drain cut into the
impervious layer intercepts nearly
all the flow.

Interceptor banks
Interceptor banks (Fig. 3) for
controlling soil salinity are being
actively promoted by some farmers.
The treatment is based on the
premise that the prime cause of
wheatbelt salinity is shallow, sub-
surface water flow which
accumulates in low-lying areas.
The banks are therefore intended
to intercept this flow and hold it,
together with runoff water, on the
slopes.
To do this the downslope banks of
the drains are lined with subsoil clay
in an attempt to make them
impervious and thus prevent
downslope movement of the shallow
seepage water. Banks can be up to
0.9 m deep.
Some banks are made on the true
contour and don't run water while
others are built on a low grade to
run the intercepted water to a
waterway.

Some interceptors, especially those
which are built on a grade and
lead water to a definite disposal
point have been observed to reduce
waterlogging downslope from the
banks. However, at other sites
well-clayed, level interceptors have
been observed to fill with water and
then overflow around one or both
ends.

Obtaining a continuous seal on the
interceptor lines has proven difficult
and bad leakage can occur at poorly
sealed points. Extensive water-
logging for prolonged periods has
been observed in such situations
(Fig. 4).
Where interceptors are effective in
cutting off shallow sub-surface flow
and draining it away to a creek, the
resulting reduction of waterlogging
and flooding may shrink the
marginal areas of salt-affected land
and also allow cultivation and
better establishment of plant cover.
Level interceptors, if they result in
depth infiltration of water into
sloping land, will increase
wettable levels and thus expand
valley areas permanently under the
influence of shallow, saline
groundwater.
Department of Agriculture
experience has shown that grader
built interceptor lines are effective
in removing shallow sub-surface
water and bulldozer construction
is not necessary for them to
function properly.
Moreover, as the aim of interceptor
drains is to stop water from sloping
areas accumulating on low-lands,
the water is best intercepted with
one drain immediately upslope from
the area to be protected. The
water intercepted should then be led
away and not allowed to seep back
into the soil where it can continue
to cause damage.
Grader construction of one
strategically placed drain
considerably reduces the cost of
interceptor drainage. Contour
banks however still may be needed
on higher land to control run-off
and erosion. The effects of an

Interceptor bank system built by Mr
H. Whittington are now being
compared with a conventional soil
conservation system on an area of
saltland near Dangin.

Conclusion
Keeping water on the slopes where
it falls is much better than relying
on drainage schemes to control
excess water once it reached
low-lying areas.
The need for surface drainage,
continues to exist however, because
farmers in the lower parts of large
catchments are unable to control
what happens on remote higher
lands. Also natural drainage
systems are frequently unable to
contain large amounts of water
resulting from unusually high
rainfall.
In poorly drained low-lying parts
the incident rain may in itself be
enough to cause waterlogging.
Grade banks, level banks, W-drains
and levees can all help alleviate
waterlogging and flooding problems
and improve plant growth.
Improved plant cover will protect
the soil and hence reduce the rise
of salts to the surface by capillary
action.
Reducing flooding may in a limited
number of cases reduce the amount
of water infiltrating into the
wettable and by doing this,
restrict the area of soil salinity.
Generally however, surface drainage
will not reclaim saltland because of
its insignificant effect on ground
water levels but will improve plant
growth on waterlogged saline areas.
Interceptor drainage has a role in
controlling salinity but it always has
to be applied with the mechanism of
salt encroachment in mind.
Intercepted water must be led away
and disposed of where it cannot do
further harm. There is no point in
intercepting winter shallow sub-
surface flow where deeper,
permanent groundwater is the
major cause of salinity.