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Salinity/Alkalinity in the Uralla-Walcha district on the Northern Tablelands of New South Wales

Extension Notes for Farmers

by
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for the
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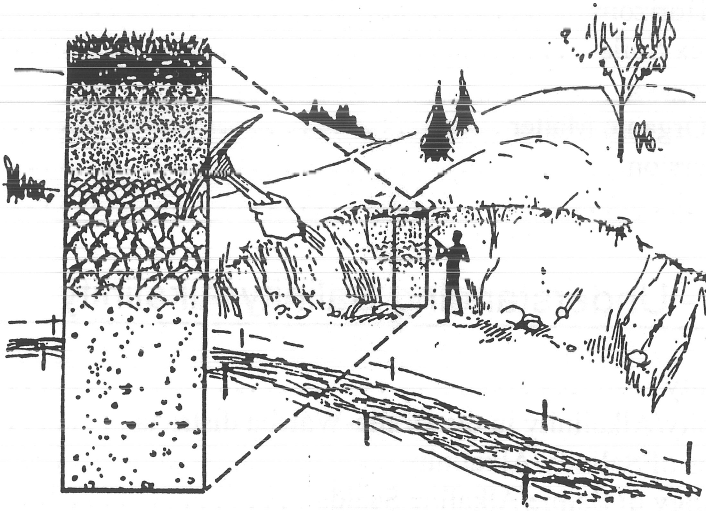
1.1 The Soil Profile

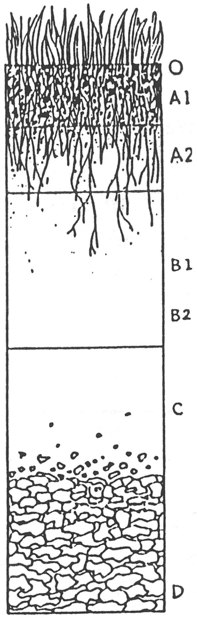
A vertical cross section through the soil, or soil profile, will usually show a series of more or less distinct horizontal layer, or soil horizons.



Source: (Brady, 1984)

1.2 Soil Horizons

Soil horizons are the different layers of soil seen in cross section. The A horizon is usually the layer which is ploughed and cultivated and the underlying horizons or subsoil, usually contain less organic matter than the A horizon.



Surface layer
The layer has organic matter sitting on top of the soil and is very important to protect the soil from raindrop action.

A1 horizon (topsoil)
The surface soil has the most organic matter and biological activity of any of the horizons. The organic matter darkens the soil colour and is a very important component.

A2 horizon
This layer is not present in all soil profiles. It is often paler that the A1 and B horizons, with poorer structure, less clay and little organic matter. The pale colour is due to the leaching of clays and organic matter, and may indicate poor drainage. It can be 5 to 70 cm thick.

B horizon
This horizon usually has more clay than the topsoil, is denser and holds more moisture, but is less fertile and can be 10 cm to two metres deep. It can also be divided in two: the B1 horizon shows a gradation between the A horizon and the B2 horizon which is much stronger in colour and structure than the B1.

C horizon (weathering rock)
The C horizon is made up of weathering parent rock, so is full of gravel, rocks and boulders. Thickness varies according to rock type.

D horizon
This horizon consist of unweathered rock.

Source: (Soil Sense 1994)

1.3 Duplex Soils

Duplex soils are easily recognized as they have a very distinct boundary change between the A and B horizon.

1.4 Aggregates

A soil aggregate is a small clump or clod of soil. It consists of grains of sand, silt and clay which are held together by clay and humus. The clay and humus in the aggregates hold moisture and nutrients for the plant roots to use.

A good well structured soil will have plenty of aggregates with spaces between them to allow air and water to pass through and roots to move down between the aggregates. Soils which are dispersed and have no aggregates are the poorest for plant growth. Sand has plenty of spaces between the grains, but cannot hold moisture or nutrients for plant use

1.5 Soil Organic Matter

Soil organic matter is any living or dead animal and plant material. Such material is continually being broken down as a result of the work of soil microorganisms. Organic matter eventually decomposes to humus, a dark crumbly material which cannot be broken down any further. Organic matter plays a crucial role in improving soil structure, recycling and storing nutrients and controlling changes in acidity and alkalinity.

The benefits of organic matter are to improve the soil structure by binding soil particles into aggregates, provide nutrients and provides mulch.

1.6 Dispersion

Dispersion results in the breaking up of aggregates into individual sections. Clay soils which contain a lot of sodium (Na) are prone to dispersion. The positively charged sodium cations are held by electrical attraction to the negatively charged clay particle.

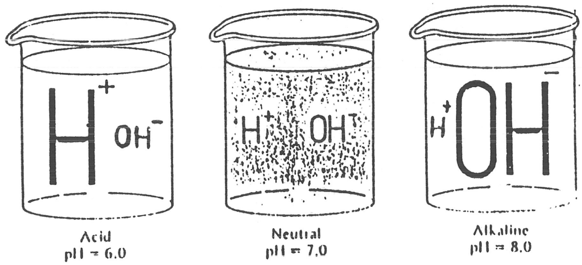
Dispersible soils are a problem because they are easily eroded by water and result in the soil surface becoming crusty and hard which results in poor infiltration and drainage with water sitting on top of the soil surface. Applying gypsum to sodic clay soils will help prevent dispersion as the calcium in the gypsum replaces the sodium and assists in the formation of aggregates.

1.7 pH

pH is a general measure of the acidity or alkalinity in soils; it gives an indication of the chemical environment and may be used as a guide to determine if the soil is suitable for different crops and pastures. Nutrient availability is also affected by soil pH and so it can be a guide to likely deficiencies and/or toxicities.

Range in pH

The pH is related to the concentration of both hydrogen ions (H^+) and hydroxyl ions (OH^-). The diagram below represents acid, neutral and alkaline situations. At a neutral level (pH 7), the numbers of H+ and OH- are equal. At pH 6 there are more H+ ions and the solution is acid. At pH 8 there are more OH- ions than H+ ions and the solution is alkaline.



Source: (Brady, 1984)

The pH of soils varies from values of 3 or less in very acid soils to more than 10 in alkaline soils. The best range for plant production is in the range from 5 to 7.

The soil pH suggests the likelihood of several troubles, for example:

pH < 5: Aluminium and Manganese toxicity, Calcium and Molybdenum deficiency

pH < 5.5 Molybdenum, Zinc, Potassium and Sulphur deficiency

pH > 7.5 Possible Salinity and Alkalinity problems, Zinc and Iron deficiency

■ Test your soil pH

You can have your soil pH tested by a laboratory or do simple tests with a test kit available at most produce stores. It is best to sample places in the one paddock and then average the results.

2.1 Salinity

Salinity in soil refers to level of salts in the soil solution (water in the soil). The most common salt is usually sodium chloride but on the Northern Tablelands it is sodium carbonate/bicarbonate. These salts can severely affect soil dispersion, plant growth and soil erosion.

■ Measurement of Salinity

Soil salinity is measured in soil tests as electrical conductivity. The higher the salt content of the solution, the higher the electrical conductivity. The unit of measurement of electrical conductivity (EC_e) is decisiemens/metre (dS/m).

■ Ratings of Salinity

Class	EC_e (dS/m)	Comments
None-saline	<2	Salinity effects mostly negligible
Sightly saline	2-4	Yields of very sensitive crops may be affected
Moderately saline	4-8	Yields of many crops affected
Very saline	8-16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few very tolerant crops yield satisfactorily

2.2 Salinity/Alkalinity in the Uralla-Walcha Districts

Salinity and alkalinity problems have existed on the Northern Tablelands of New South Wales for a long time. Saline/alkaline patches or scalds are widespread throughout the region, particularly on trap rock country and are generally characterised either by bare patches of ground or support a sparse cover of couch (*Cynodon dactylon)* and/or sea barley grass (*Hordeum marinum*). Stock make the problem worse by compacting the soil through trampling and grazing and by licking the top of the B horizon where it is exposed. Improved pastures usually do not grow on saline/alkaline scalds because of high pH levels (over 10) and poor soil structure.

The potential of saline/alkaline scalds to spread is of major concern to landholders, yet the processes involved in the formation of these patches is not clearly understood. The formation of saline/alkaline scalds seem to depend on variations in seasonal rainfall patterns. The whole soil profile can become saturated during very wet periods. Excess water will then seep through fissures in the underlying rock or more down slope on top the B horizon in duplex soils, dissolving soluble salts as it goes. This water may then come to the surface at specific points in the landscape and the salts are concentrated as the water evaporates. The scalds therefore become most obvious in a dry time following a very wet season. During good seasons high concentrations of soluble salts in the soil will be leached out and the saline/alkaline patches appear to heal. The way to prevent the spread of saline/alkaline scalds is to avoid the buildup of salts which occur in the soil during dry times by implementing techniques which will be explained in part three.

Saline/alkaline scalds in the region vary in their size, shape and degree of severity. Some scalds are only a few metres across while others spread as far as 50 metres or more.

2.3 Types of Salinity/Alkalinity

Saline/alkaline scalds on the Northern Tablelands can be classified as one of the following:

a) Green spring - these areas are natural springs with a low salt content and green vegetation present all year round. The rocks through which the water flows must be low in salts so that the water is relatively pure when it comes to the surface. Salts do not accumulate.

b) Scalded spring - these areas are similar to green springs but the water has a higher salt content and the soil is bare. Salts usually crystallise on the surface of the waterlogged soils.

c) Green local - vegetation is present on these sites all year round and generally consists of couch, sea barley grass and swamp foxtail grass. They are not always waterlogged, but when rain falls they tend to become boggy and sticky and water doesn't flow into the soil profile..

d) Scalded local - these areas are bare of vegetation all year round but become sticky and boggy after rain falls and dry and crusty during dry periods.

You can find out if carbonates/carbonates are present in a scald by placing a few drops of hydrochloric acid on the surface of the soil. Carbonates and bicarbonates are present if the acid causes a fizziness and bubbles

The scalds on the Northern Tablelands are both saline and alkaline the salts responsible consist of both sodium and carbonates. The salt responsible for salinity in other areas of Australia consists of sodium chloride and are generally not alkaline.

2.4 Geology of Saline/Alkaline Scalds

Saline/alkaline scalds are found in areas with granite and sedimentary rocks which have a marine origin. Basalt areas generally do not appear to be affected by saline/alkaline scalds in the Uralla and Walcha districts.

These sedimentary beds consist of a number of permeable and impermeable layers containing cracks and fissures which allows ground water to flow in irregular patterns. Generally these rocks contain higher than normal levels of sodium and potassium in comparison to calcium and magnesium. It is these ions which can be responsible for the accumulation of soluble salts at the soil surface.

2.5 Where Does Salinity/Alkalinity Occur in the Landscape?

Saline/alkaline scalds are mostly found in mid slope to lower positions (2-3% slopes) and usually on the side of a valley with the gentlest slope They occasionally occur in any position in the landscape. A small number of scalds on the Northern Tablelands occur on slopes less than 2% and no scalds have been found on slopes greater than 3%.

2.6 Where Do Soluble Salts Concentrate?

The soluble salts are usually concentrated on the surface of the soil and also on top of the B horizon as a result of surface and lateral flow of water carrying soluble salts. These dissolved salts concentrate as a result of evaporation and capillary action which may brings salts to the surface.

2.7 Types of Soils Prone to Salinity/Alkalinity

The soil types most prone to salinity/alkalinity problems are solodic soils with an alkaline B horizon. These are duplex soils and the A horizon is usually a loamy sand, the B horizon a clay.

2.8 Key Recognition Features

The following features can be used to initially identify a possible saline/alkaline scald site:

- stock congregating on and licking the surface of the soil;
- grasses dying and bare patches of soil appearing;
- surface of the bare soil is "puffy" to walk over;
- soil becoming wet and sticky when waterlogged;
- salt encrustations appearing on the soil surface and at the interface of the A and B horizons;
- trees dying for no apparent reason (near vicinity of the scald);
- excess quantities of water flowing from the areas;
- pH at the soil surface of 9 and above and it may increase down the soil profile;

3.1 Reclamation of Saline/Alkaline Scalds

There are a number of techniques which can be used to reclaim saline/alkaline scalds. The main task is to counteract the concentration of soluble salts at or near the soil surface. Any bare surface will then become re-vegetated restoring some productivity to the landscape.

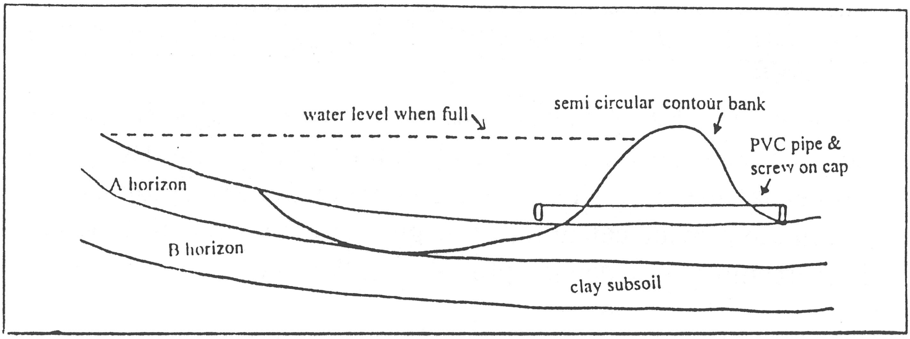
One technique or a number of techniques combined may be necessary to achieve these ends. The technique used will depend on the features of the scald such as slope, landscape position etc.

Work was undertaken in a study conducted by the author for the Bozo and Harnham landcare groups to test various techniques to reclaim saline/alkaline scalds on the Northern Tablelands. From the study three useful techniques were:

1. Ponding
2. Reverse Interception Drains
3. Chemical Ameliorants such as gypsum and epsomite

3.2 Ponding

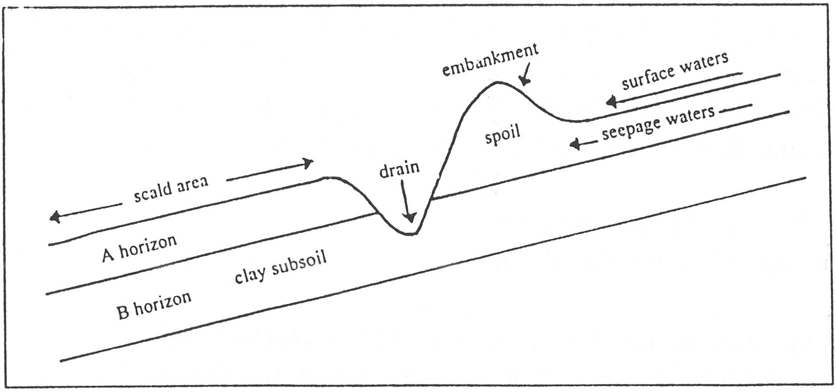
Ponding involves flooding an affected region, so that the soluble salts in the topsoil dissolve in the ponded water and can be removed through a drainage system. Leaching works in a similar way to flooding except that the soluble salts are dissolved and leached down the profile and removed via a subsoil drainage system.



3.3 Reverse Interception Drains

Interception drains are those which intercept seepage water moving down hillsides and are usually positioned on sloping land. Open interception drains collect both surface and sub-surface water.

Saline/alkaline scalds are occasionally flooded and surface and subsurface drainage can be used to prevent or reduce flooding and to improve soil conditions for plant growth.



3.4 Chemical Ameliorants of Gypsum and Epsomite

Gypsum provides calcium and epsomite provides magnesium to the soil. These two cations are important for plants and are lacking at saline/alkaline scald sites. The recommended rate is 5 tonnes per hectare to provide calcium and magnesium to replace the sodium ions creating the dispersion problems in the soil.

3.5 General Guidelines on which Techniques to use

The following notes are a general guideline about the appropriate treatment to use in different situations.

a) flat land (not waterlogged)
- apply either gypsum or epsomite at 5 tonnes per hectare.

The addition of gypsum or epsomite would only be effective on scalds on flat slopes or almost flat land because the movement of surface water will wash the chemicals away. The epsomite produce more rapid cracking of the soil surface than gypsum whereas the gypsum, after two and a half years, will probably produce a greater change in the water infiltration rate. It may be that a mixture of both chemicals will be the most effective treatment.

b) flat land (waterlogged)
- reverse interception drains.

c) medium slopes 1 to 2 % slope (not waterlogged)
- construct either ponds or reverse interception drains.

Ponds will only be effective on slopes between 1 and 2% because on steeper slopes the wall will be too high and will require too much soil to build. It is important to locate the PVC pipe so that most of the water will drain away. The disposal area of the water must not be another scald and must disperse rather than concentrate the dissolved salts.

(d) Steep slopes
- construct reverse interception drains

Reverse interception drains are perhaps the most versatile of the treatments tested with respect to position in the landscape. They are ideal for scalds near the bank of a water course because the solute laden water moving down slope can be easily directed into the water course. Reverse interception drains on nearly flat land can possibly be combined with chemical ameliorants. This treatment was effective on slopes up to 3% and could possibly be used on steeper slopes with some modifications.

(e) Sites not covered above
- require the use of common sense in regard to the local landscape features and slope where the saline/alkaline scald occurs.

The above treatments will produce some reclamation of scalds within a year or two, depending on rainfall events.

Simply fencing sites, whilst preventing compaction and erosion from stock trampling, does not appear to be an effective treatment in reclaiming saline/alkaline scalds on the Northern Tablelands. Although it may be necessary to exclude livestock from ponded areas to prevent damage to the ponds by livestock.

Part 3 - Reclamation Techniques

Whilst tree planting and management of pastures to maintain deep rooted perennials grasses is recommended as part of a whole farm plan, no specific recommendations can be made as to where to plant trees in relation to a scald site. Trees would not normally be planted on scalds because of the poor growing conditions.

N.B. Whilst every care is taken to ensure accuracy and reliability in the information no responsibility for the consequences which may arise from acceptance of recommendations or suggestions made can be accepted, as many other external factors may come into effect.

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