3. Environmental rules – striking the balance

The use and management of peat soils in the Waikato region must be consistent with the policies and rules of Environment Waikato. Peat farms that have significant wetlands on their boundaries will be subject to drainage restrictions that are based on the need to protect these wetlands.

Environment Waikato’s Proposed Waikato Regional Plan (1998) controls land drainage in areas adjacent to identified wetlands and within wetlands bigger than 1 hectare, to avoid further degradation of these rare and valuable ecosystems. Identified significant wetland areas are listed in the Proposed Plan, which is available from Environment Waikato.

The following drainage activities are classed as discretionary¹² in the Proposed Waikato Regional Plan:

- the creation of new drains or the deepening of drain invert levels¹³ in areas adjacent to and within 200 metres of the edge of identified wetlands
- the creation of new drains or the deepening of existing drains in a wetland bigger than 1 hectare.

This means that landowners must apply to Environment Waikato for a resource consent to undertake these activities, which may be granted or refused depending on the likely environmental effects. These rules are designed to generate a buffer between activities on developed peat land and neighbouring significant sensitive wetlands.

The Proposed Waikato Regional Plan also contains rules about the diversion of water, which may be relevant to farmers diverting or discharging water in an artificial watercourse or drainage system in peatland areas. Environmental rules aim to strike a balance between the need to protect environmental values and the need to maintain productive land uses.

Environment Waikato staff can also provide advice about the protection of wetland areas. A series of wetland restoration fact sheets have been prepared and are available free from Environment Waikato.

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¹⁰ van der Elst, F.H. 1980b.
¹¹ Soils information from the New Zealand Land Resource Inventory, Landcare Research. Digital terrain image supplied by Terralink NZ Limited. Copyright reserved.
¹² A resource consent is required from Environment Waikato, which must exercise its discretion to grant the consent in accordance with its Regional Plan and section 104 of the RMA.
¹³ Drain bed levels.
4. Drainage – damned if you do, damned if you don’t

4.1 Why deep drains are not good drains

Effective drainage is a key factor in the management of peat soils. However, drainage inevitably damages the peat resource. As soon as peat is drained and the water table lowered, the natural process of accumulating organic matter stops. The surface of the land then starts to subside as the organic matter shrinks and decomposes as a result of exposure to air (oxidation) and compaction due to agricultural practices. Table 4 shows subsidence of peat over time as measured at three different sites in the Waikato region.

Table 4: Average annual subsidence of peat at different locations in the Waikato region

<table>
<thead>
<tr>
<th>Site</th>
<th>Average annual subsidence (mm/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hauraki Plains</td>
<td>18</td>
</tr>
<tr>
<td>Rukuhia</td>
<td>25</td>
</tr>
<tr>
<td>Moanatuatua</td>
<td>33</td>
</tr>
</tbody>
</table>

The rate of subsidence is determined by:
- drain depth and spacing affecting water tables
- thickness of the original peat
- mineral content of the peat
- compaction rates.

Research at Moanatuatua has estimated that on average 63 per cent of peat subsidence over 40 years of pastoral farming was due to compaction, with the remaining 37 per cent caused by loss of organic matter (oxidation).

Managing the water table is the best way for farmers to slow peat shrinkage. Studies show that subsidence rates are highest where water tables are lowest. Where peat soils are over-drained, it is likely that some areas of peat land will ‘sink’ below current water levels, increasing the need for stopbanking and pumping stations. This will significantly increase the cost of farming these soils.

The deeper and more closely spaced the drains, the quicker the peat will subside. Table 5 shows how deeper drains can increase peat subsidence. There is a fine balance between achieving the right drain spacing and depth to maintain good pasture production, yet avoid over-drainage and accelerated shrinkage.

Table 5: Predicted peat subsidence (m) away from drains of different depths.

<table>
<thead>
<tr>
<th>Drain depth (m)</th>
<th>25</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.07</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.5</td>
<td>0.28</td>
<td>0.17</td>
<td>0.05</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>0.49</td>
<td>0.34</td>
<td>0.18</td>
<td>0.09</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2.5</td>
<td>0.70</td>
<td>0.51</td>
<td>0.31</td>
<td>0.19</td>
<td>0.11</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Research shows that the higher the mineral content of the peat, the more slowly it subsides (table 6). Subsidence is faster in recently developed fibrous peat but slows down as the mineral content gradually increases over time.
Table 6: Average annual subsidence of peat at Moanatuatua research area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Initial mineral content (%)</th>
<th>Average annual subsidence (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-150 mm soil depth</td>
<td>150-250 mm soil depth</td>
</tr>
<tr>
<td>Back paddocks</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Middle paddocks</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Front paddocks</td>
<td>25</td>
<td>13</td>
</tr>
</tbody>
</table>

When drains are cut through peat into permeable layers of coarse sandy subsoil, shrinkage can be severe, leading to both subsidence and the formation of cracks. These cracks can be between 50 to 100 mm wide and up to several metres long. Over-drained peat often fails to re-wet in winter both because the dry peat becomes waxy and because rainwater flows through surface cracks into the subsoil. The productivity of such land becomes very poor.

Recommendation 1: Avoid deep drainage.
Deep drainage of peat results in over-draining and rapid subsidence of peat soils. It can also cause cracking, making soils difficult to re-wet. As well as speeding up the degradation of our unique peat resources, these practices make life more difficult and expensive for farmers.

4.2 Managing your drains well

4.2.1 Key principles
There are two key principles in good drain management:
- maintaining the water table during summer
- fencing and weed control to reduce maintenance costs.

Water table management
Ideally, drainage systems should be designed not just to remove excess water during the winter but to maintain the water table during the summer to prevent over-drainage. This is not always possible without a complex drainage system but drainage can be optimised by maintaining water levels at an average of around 0.5 metres below the surface. Winter water levels will rise and summer levels will drop even when managed carefully.

To minimise both peat shrinkage and excessive soil drying during the summer (which retards pasture and crop production), the water table should be maintained as high as possible (up to within about 0.5 metres) for any given land use. Very low water tables will expose more of the peat to oxidation and shrinkage, shortening the life of the peat resource. Higher water tables from spring to autumn will improve grass growth. This is especially important for hump and hollow paddocks, where humps can dry out during summer, reducing grass growth.

Water table depth largely determines the degree and depth of aeration, which has a major effect on plant growth. Table 7 shows the water table depth required for different plants. Shallow fibrous rooted plants, including most pasture species, require a high water table.
One of the best ways to prevent the water table dropping too much in the summer is to block secondary drains off in late spring before they run dry. This can be achieved using simple and inexpensive techniques, such as the use of sandbags to dam drains. Alternatively, water control structures can be developed in secondary drains (figure 4). Such structures would need to isolate the water table for some distance either side of the drain to avoid bypass flow. Farmers in the Lake Serpentine catchment are using weirs with wooden planks laid horizontally that can be inserted and removed as required, with positive results.

Water table management can be difficult on an individual farm basis because groundwater is a resource without boundaries. Getting together with your neighbours to discuss summer water table management can be a useful start. If you are interested in forming a landcare group to better manage water tables and protect your local peat resource, contact Environment Waikato – we are happy to help you get started. Better water table management will minimise shrinkage, allowing you to extend summer grass growth and farm your peat soils profitably for longer.

Recommendation 2: Maintain the water table over summer.
Maintaining the water table as high as possible in drier periods is better for both pasture growth and the health of your peat soil.
Water table management in action: Loch Carron Farm, Island Block

Peter Buckley’s 103 hectare family farm is on the edge of the internationally important Whangamarino wetland. The Buckley’s farm has produced around 1000 kg milk solids over recent seasons and Peter has developed a reputation for his careful water table management. Drainage on the farm is controlled by pumps on the edge of the wetland. Every year in mid December, Peter adjusts the pump’s float switch to allow the on-farm water table to rise, providing for production over the drier summer period and minimising shrinkage of his peat soils. Drainage resumes in mid February.

The lack of stumps rising out of the timber-packed peat is clear testimony to the fact that this type of management has minimised shrinkage to negligible levels – the farm was last stumped over 20 years ago. “It’s a matter of monitoring the weather, the rain and the grass,” says Peter, whose farm is actually 6 feet lower than the neighbouring Whangamarino wetland. “There can be a fine line between too much water and not enough”. There is a clear incentive to minimise peat soil shrinkage, as flood pumping costs would be very high if the farm was to lower any further. Much of the peat area is currently only 1 metre above sea level and in some areas the peat layer goes down 94 feet!

Peter has fenced all drains on both sides, reducing the need for drain maintenance considerably. Many would also be surprised to hear that his peat paddocks haven’t been cultivated since 1981. Around 1 tonne of lime is surface-applied on the farm every three years. He doesn’t have stock on the wetter paddocks during winter, instead using the loam and clay areas of the property. He also moves stock frequently over wetter periods, which avoids the need for a stand-off pad. Being next to Whangamarino, the Buckley farm sometimes hosts fernbirds and Australian bittern, not to mention the inevitable hoards of pukeko! Peter views it as similar to the Great Barrier Reef – a living organism in its own right and a unique asset on his back doorstep.

Fencing and weed control

Machine cleaning of drains can be expensive. Drains only need to be cleaned if their ability to function has been reduced by silt or weed growth. Most of the silt that ends up in drains is a result of stock damage to drain banks. If drains are fenced on both sides to prevent stock access, the need to machine clean drains is substantially reduced, which in turn reduces costs to farmers. Fencing drains can reduce the frequency of machine cleaning from every 1-2 years to every 5-8 years. A single electric wire is all that is required on most dairy farms. Stock losses are also reduced and the clean banks of fenced drains prevent production losses from erosion.

Weed growth is a result of weed seeds and nutrients in the waterways. Nutrients are difficult to keep out of drains but they can be minimised by fencing drains. Drains should be sprayed in summer (January/February) to kill weeds before they seed. It may also be necessary to spray in spring if weed growth has been vigorous. Weed control in drains should be undertaken using glyphosate (RoundUp) as it is the only herbicide approved for use over water.

Leaving a small strip (around 1 metre wide) of permanently ungrazed grass between the drain and the fence will help to reduce run-off of sediment, nutrients and bacteria into waterways. The grass will act as a nutrient filter and will also provide stability to the drainbank, reducing erosion.

Recommendation 3: Fence drains to exclude stock and control weeds with spray to reduce maintenance costs. Less machine cleaning of drains not only saves money but also reduces both impacts on water quality and the risk of drain deepening.

van der Elst, F.H. 1980b.
4.2.2 Dealing with different drain types

Peat drainage systems are typically made up of a hierarchy of three main types of drains:
• paddock ditches and drains
• secondary drains
• main drains.
Good management can be slightly different for each drain type.

Paddock drains

There are two methods of drainage within paddocks:
• conventional open ditch or box drains
• ‘hump and hollow’ formations.

Conventional ditches

Conventional ditch drains often form the boundaries between paddocks and feed into secondary drains. Ideally paddocks will be shaped using drain cuttings to form a dome at the high point in the paddock, assisting surface run-off (figure 5). The base of the drain should have a shallow U-slot trench to move water effectively and retain the water table at the base of the paddock. The U-trench need only be 0.5 metres wide and deep. The further down the catchment, the larger the U-trench should be. If extra capacity is needed, the drain should be widened not deepened.

Figure 5: Paddock contour with conventional ditch drains

Because shrinkage is greatest close to the drain, the dome shape between paddock drains is maintained over time. Shallow mole drains at right angles to the paddock drains assist with sub-surface drainage during wet periods. Shallow spinner drains can be useful to remove surface run-off from wetter areas.

Hump and hollow

The fibrous topsoil of most undeveloped peats allows water to flow sideways freely to enter drains. As the top layer of soil consolidates, sideways movement slows down considerably, and surface run-off becomes the ideal way to remove surplus water while avoiding over-draining in summer. The hump and hollow system is designed to capture this surface run-off as efficiently as possible.
The disadvantage of hump and hollow drainage is the wet hollow areas where stock can pug and damage soil structure. Surface run-off from the hollows is likely to carry increased levels of sediment, which may increase drain maintenance costs.

Hump and hollow drainage is generally used during the earlier stages of peat development. As the peat subsides over time, it may be more effective to move away from hump and hollow to paddock shaping and subsoil drainage.

Secondary drains

Secondary drains collect water from paddock drains and feed into main drains. They are often constructed in pairs, one on either side of farm tracks, and are called paired track drains. Normally they only need to be 0.5 to 1.3 metres deep, and should be fenced on both sides to prevent stock access. Paired track drains can be set at 500 metre intervals if fed by a hump and hollow system but should seldom be more than about 150 metres apart if not supported by comprehensive withinpaddock drainage.

Drains on the edge of farm tracks are especially at risk of run-off contaminated with nutrients and bacteria from stock waste. To minimise the effects on water quality, it is helpful to leave a permanently ungrazed strip of grass between the fence and the drain, which acts as a filter.

Main drains

Main drains are usually no deeper than 1.5–1.8 metres. They carry surplus water away from the farm and often run along property boundaries and next to roads. They should be fenced on both sides. Limiting culvert sizes and the width of ditches in consultation with your neighbours can help to control the speed of water movement to neighbouring properties and main outlets. It is also important not to deepen main drains when they are cleaned out, as continual deepening will eventually lead to over-drainage. In drainage districts, main drains are usually maintained by district councils or Environment Waikato through separate drainage rates.

Recommendation 4: Do not deepen drains during maintenance. Continual deepening will lead to over-drainage, affecting pasture production.
5. Maintaining your water quality

5.1 Natural water quality in peat areas

The quality of surface water and groundwater draining peat areas is generally poor for drinking and stock watering. It has a naturally low pH and is high in tannins, which give it a tea-coloured stain. It also tends to be high in iron, which taints the water and clogs pipes when it precipitates out.

As a result of this naturally poor water quality, farmers will often need to treat existing water or look for alternative sources. It can be more cost effective in the long term to locate a source of good quality water than to treat water. Generally, it is necessary to drill deep groundwater bores through the peat and into the underlying mineral soil to find good quality groundwater. A resource consent is required from Environment Waikato to install a groundwater well or bore. Environment Waikato has information about existing bore locations, depths, water quality and flow, which could be useful when deciding to install a new bore.

If a good water source is not available, water treatment may be necessary. There are two types of treatment systems available – chemical and aeration – both of which rely on oxidising the iron into an insoluble form and removing it through a filter.

5.2 Avoiding contamination of drains and streams

Because peat soils have a high water table and high level of surface run-off, the waterways that drain it can be more vulnerable to contamination from different land use activities. Run-off from the land carries with it sediment, bacteria and nutrients that are generated from stock grazing and fertiliser application.

5.2.1 Streamside (riparian) management

Streamside or riparian management refers to a range of techniques for managing the areas next to waterways to reduce the impacts of land uses on water quality. The riparian margin (the immediate edge of the waterway) and its vegetation has an important role in providing bank stability, shading and woody debris to the aquatic environment. It also acts as a buffer, absorbing excess nutrients and trapping sediment and waste material before they enter the waterway.

One of the most important techniques of streamside management is reducing stock access to waterways. Bacteria from animal dung and urine can reduce the quality of waterways for swimming and for use on the farm. Nutrients from dung, urine and fertiliser can lead to the growth of algae and nuisance plants in waterways. If riparian areas are fenced to keep stock out, they can also be planted to create a buffer of vegetation between pasture and waterways. However, it is important to provide for machine access to clean drains – planting should not impede this.

Recommendation 5: Keep stock out of waterways.

Stock that have access to waterways can cause bank erosion and increase sediment levels in rivers. Stock may also deposit urine and dung in waterways, which increase bacterial levels and may affect human health.
5.2.2 Offal holes

Farm offal holes are a permitted activity in the Proposed Waikato Regional Plan, subject to a number of conditions. The lowest point of the offal hole must be at least 1 metre above the level of the seasonally shallowest water table, to minimise the risk of contamination. It can be very difficult to meet this condition on peat because of the high water table. Offal holes are therefore not recommended in peat areas.

**Recommendation 6: Don’t put offal holes on peat soils.**
Put offal holes on mineral soil if you have any, otherwise dispose of offal off the farm.

Well fenced drain with a buffer of grass
6. Cultivation – a necessary evil?

6.1 Cultivation and its effects on peat soil

Peat is naturally anaerobic (no oxygen available) and very acid (soil pH < 4.5). The plants that grow naturally on peat, such as Sphagnum moss and Hypolaena, are not only tolerant to acidity but have shallow spongy roots which carry oxygen down to the root tips.

For plants without these special features to grow in peat, the soil must be aerated and the acidity reduced. Cultivation creates a layer of peat, which is sufficiently aerated and has the correct pH to support the growth of pastures and crops.

Organic matter is also highly resistant to pH change, which means that large amounts of lime are required to change the soil pH. Surface applied lime does not move down into the soil profile, so lime needs to be incorporated into the subsoil during cultivation. Research shows this method can result in a 65 per cent increase in production.

Cultivation may need to be repeated over time as the cultivated peat decomposes (at an average rate of 25 mm per year\(^1\)) and becomes too shallow to sustain pasture. This is especially the case in dry weather and is signalled by the appearance of dry knobs in the soil. The knobs become more widespread until the paddock has to be cultivated, levelled or shaped and regrassed to become productive again.

As peat mineralises over time, the intervals between pasture renewal can be increased. Good pasture management can also reduce the need to cultivate. Chapter 7 discusses techniques that can help extend the life of your pasture.

The less cultivation that you do, the longer your peat soil will last. Continuous cultivation accelerates the rate of shrinkage more than twice that of peat soil under permanent pasture. Cultivation increases aeration and mechanical breakdown of soil particles and decreases water permeability. Losing soil faster also affects crop production – rooting depth is reduced and plants dry out faster in the summer.

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\(^1\) Continuous cultivation accelerates the rate of peat shrinkage!
Damage to soil structure is the main obstacle to repeated cropping on the same area. A poor soil structure will reduce productivity for both pasture and crops. If cropping cannot be avoided on peat, ensure long intervals in pasture to minimise shrinkage, maintain good soil structure and improve soil nitrogen status.

Recommendation 7: Minimise cultivation of peat soils.
Cultivation should be avoided where possible as it causes peat to shrink twice as fast as it does under pasture. If cultivation is done correctly during pasture renewal, the intervals in between can be extended significantly. The next section discusses good cultivation practices. Managing your pasture well also reduces the need for pasture renewal.

6.2 Good cultivation practice

6.2.1 Equipment and methods
Cultivating equipment should be selected to avoid pulverising and chopping the peat too fine, which can destroy the fibrous structure of the soil. Avoid using rotary hoes at all on peat soils. Cultivation should ideally have a minimal impact on soil structure. This can be achieved with disc ploughs, power harrows, chisel ploughs and paddle ploughs. “No-till” methods, such as direct drilling, can be an effective way of renewing pasture on developed peat while avoiding effects on the soil, saving time in paddock preparation and even reducing costs. However, techniques such as direct drilling require careful planning. Your farm consultant will be able to provide more information.

Recommendation 8: Use no-till methods to renew pasture where possible.

Very shallow peat soil can dry out quickly and become unmanageable in summer. One option to address this problem can be to mix underlying mineral soil with the peat to improve its moisture-holding and re-wetting ability. Bob Dawson has achieved good results using this technique on his Horsham Downs property. Paddocks that once grew no grass during the summer are now producing well. This technique could have potential even on very deep peat to assist in slowing the rate of shrinkage and improving moisture-holding ability, although the cost could outweigh the benefits.

6.2.2 Cultivation depth and water table management
When cultivation is required to incorporate lime, it should be to a depth of around 200-250 mm to provide a maximum rooting depth for pastures and crops (figure 6). This is most important during the earlier stages of peat development when the peat is undergoing the most shrinkage. Mixing the lime to a good depth is important because as the peat shrinks over time, pasture roots get closer to the underlying lower pH soil. If cultivation is deep enough at the outset, it is likely that pasture will respond better and cultivation intervals can be extended, reducing both costs to the farmer and effects on the peat resource.

Recommendation 9: If you have to cultivate, do it to a good depth and with equipment that creates minimal disturbance.

Cultivation intervals can generally be extended out after two pasture renewals, if coupled with good water table and pasture management. Shrinkage and irregular subsidence of the soil surface will continue, although at a slower rate. Deep cultivation will still be necessary unless the downward movement of lime keeps pace with the rate of shrinkage. Soil tests can be used to determine pH and lime requirements. When measuring soil pH before cultivation, soil should be tested at depths of 0–75 mm and 75–150 mm to get the best assessment of lime requirements.

One of the most important management factors to reduce the need for subsequent deep cultivation is water table management. Minimum drainage compatible with good pasture growth is ideal. Chapter 4 provides information about methods for achieving this.
7. Managing pasture on peat

7.1 Sowing pasture

Because new varieties of pasture are continually being developed, use your farm consultants to provide up to date information about the best pasture species for different areas and objectives.

It is common practice to sow pastures in autumn. This prevents summer weeds from becoming established before the slower grass and clover species have formed a dense cover. It also avoids the effects of summer drought when the pasture is establishing. Spring sowing has been successful on peat areas not subject to summer drought, such as low-lying wet areas. The nitrogen fertility of newly sown peat is very low, so nutrient management programmes should take this into account.

If the soil is suitably damp, pasture can be sown in early March and grazed initially in April. If the soil is dry, it is best to delay sowing until late April or early May, when moisture conditions are likely to be more favourable. Under-drilling established pasture should be done no earlier than the end of April to avoid a poor strike.

7.2 Weed control

Some chemicals used for weed control may behave differently on peat soils than on mineral soils. Many soil-applied herbicides used for cropping either do not work very well on peat soils or have to be applied at much higher than the recommended rates on peat soils because of its high adsorptive capacity20.

Where available, post-emergence herbicides should be used as their activity is not greatly affected by the soil. Where a herbicide has pre-emergence as well as post-emergence activity (e.g. atrazine for control of weeds in maize), post-emergence applications would be preferable.

Contact your local plant pest officer or chemical supplier for further advice about the best herbicides for your situation.

7.3 Grazing management

Good management of stock grazing will minimise the degradation of peat soils and ultimately save on costs for pasture maintenance. Maintaining a dense pasture sward is one of the best ways to protect your peat soil – ideally a grazed paddock will be left with between 1200–1400 kg of dry matter per hectare.

Overgrazing of pasture on peat soils should be avoided because:

- pasture will die back in summer, increasing the need for renewal (discussed in chapter 6)
- bare soil patches heat up during summer and therefore shrink faster, degrading the peat resource and causing an uneven paddock surface.

In winter when the water table is relatively high, high stocking rates can lead to pugging, which damages soil structure and accelerates shrinkage. Use of well-constructed stand-off or feed-pads can be a good way to conserve feed and minimise pugging during the wetter winter months. However, it is important that effluent and soil material from these pads is managed correctly to avoid contaminating waterways.

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20 The soil’s ability to bind chemical compounds to its particles.
Suggested methods to minimise contamination of waterways from feed pads:

- Use wood chips or bark material to absorb effluent – it can then be composted and used as a soil conditioner.
- Collect effluent and pipe it into an existing two pond or barrier ditch system before either discharging it to land or treating and discharging it to a waterway\(^2\). Your system will need to be sized according to the expected volume of waste.
- Collect effluent and apply onto to land at a rate of up to 150 kg of nitrogen per hectare per year.

Modern electric fence technology has greatly reduced the cost of fencing. It also allows much greater flexibility and makes it possible to change, at little cost, the internal subdivision of the farm.

Soil pugging: Not good for the peat, no fun for the cows!
Managing pasture for profit
– O’Leary Farms Ltd, Gordonton

Brendan O’Leary’s Gordonton dairy farm achieved its highest ever production over the 1998-99 season – 1,200 kg of milk solids, proving just how productive peat soils can be when well managed. “My neighbours keep asking me what I’m up to next” says O’Leary, who is a forward thinking farmer and entrant in the 1999 Farm Environment Awards. He acknowledges that peat can be difficult to farm and has adopted particular pasture management practices to protect and extend the life of his peat soils. He feels the key to good pasture management is careful monitoring of pasture levels and growth. Stock are taken off paddocks every day over the winter (starting as early as May) to keep up residual cover at around 1,200 kg of dry matter per hectare.

Spoil from drain cleaning is used to build up the centre of cultivated paddocks, rather than left in heaps beside drains. Bare patches in pasture have been oversown to maintain cover, at the same time protecting the soil. Brendan has also planted a number of trees on the farm to provide shelter for stock. So far, plane trees have done the best and provide a welcome addition to the farm landscape. Exploring options for water table management could be the next step on the farm, as Brendan experiences the typical problems with peat of keeping the water table up during summer and early winter.

7.4 Avoiding peat fires

Fires on peat are prohibited during summer by district councils and the Department of Conservation in most areas of the Waikato. Peat soils are highly flammable during dry periods and will burn underground for months on end if not contained. For example, in 1998 a peat fire in Te Hoe burned for several weeks and over $100,000 was spent on helicopters and water pumping in an unsuccessful attempt to put it out.

A few simple techniques can be adopted to prevent peat fires. These include:

- Never burn anything on or near peat during dry periods.
- Always contact your local district council to check the fire prevention status before you burn anything on or near peat.
- Wash engine driven machinery after use during dry periods to prevent peat or dry grass catching fire on exhaust manifolds.
- If you need to burn wood or vegetation outside fire-ban periods in your area, do so on safe areas such as a metalled farm race or tanker track, a clay area or concrete. Ensure that the wind will not spread the fire into peat areas.

If peat does start burning, contact your local district council’s principal rural fire officer or the Department of Conservation immediately.

Recommendation 10: Don’t light open fires on peat during dry periods. Peat is highly flammable and will burn underground for long periods. It is very difficult and costly to extinguish a peat fire.

Any direct discharge to a waterway will require a resource consent from Environment Waikato.
8. Getting your fertiliser right

8.1 What does peat need?
Waikato peat soils have a naturally low nutrient status. Accordingly, the nutrients required to sustain pasture, crop and animal production must be applied to the soil as fertilisers. Lime is also required to increase the soil pH to an appropriate level for pasture and crop species. Soil and herbage tests are the best way to determine exactly what fertiliser your peat soil needs. Fertiliser consultants will provide advice about what products best suit your needs.

Applying the correct amounts of the right type of fertiliser will maintain good pasture for longer periods, reducing the need for frequent cultivation and pasture renewal. If you have the right nutrient management programme for your farm, you can reduce both cultivation and renewal costs, and prolong the life of your peat soil at the same time.

8.2 Good fertiliser application

8.2.1 Timing
Timing of fertiliser application should be so that plant uptake is maximised and any potential effects on the environment are minimised. Farmers need to be aware of the solubility (or mobility) of the nutrient or fertiliser they are using, the nutrient demand of their crop and the nutrient fixing capability of the soil. The amount of rainfall experienced or expected should also be taken into account.

Recommendation 11: Apply fertilisers in split dressings in spring and autumn. Direct loss of nutrients by leaching is greatest in winter. Spring and autumn applications are more effective and less damaging to waterways.

8.2.2 Efficiency
Ideally, farmers should achieve 100 per cent efficiency when applying fertiliser – that is, fertiliser is uniformly and evenly applied, with none outside the target area. In practice, however, this is difficult to achieve, so it is a matter of achieving maximum efficiency while minimising environmental effects.

Rapid response fertilisers require more accurate application (rate and distribution) because the production loss and potential for environmental effects is greater. Effects are likely to be reduced with slow response or less concentrated fertiliser, so less accurate application may be more acceptable.
Recommendation 12: Apply fertiliser as accurately as possible, especially rapid response fertilisers.
The higher the accuracy of application (rate and distribution), the less likelihood of environmental effects.

8.2.3 Minimising leaching and run-off

Peat soils typically have a low Anion storage capacity\(^{22}\) (around 20) – this means they have little ability to hold nutrients in the soil to prevent leaching to ground water. Increased leaching of fertiliser can occur when water tables are near the ground surface. Elevated levels of nitrate in ground water can mean it is unsafe for drinking. Surface run-off containing fertiliser can also contaminate drains, rivers and streams (see chapter 5).

Strategies to minimise the risk of nutrient leaching include:

- apply fertilisers in split applications in spring and autumn
- apply not more than 30 kg/ha nitrogen and 100 kg/ha phosphorus in any one application
- apply ammonium forms of nitrogen (e.g. urea, ammonium sulphate) rather than nitrate forms of nitrogen
- do regular soil and herbage tests, allowing you to match nutrient inputs to soil requirements
- undertake nutrient budgeting to ensure nutrient inputs match production goals
- avoid the direct input of fertiliser into streams and waterways during application
- use granulated fertilisers if possible as they can be spread more evenly and accurately.

To avoid contamination of waterways from direct ground fertiliser application:

- allow a good margin between the fertilised area and the waterway
- use application techniques that direct the fertiliser
- use fertiliser with a larger particle size (less wind effect)
- erect a physical barrier or plant a riparian strip on the edge of the waterway
- load fertiliser away from waterways and in a sheltered area.

Riparian strips surrounding waterways act as a filter to reduce the amount of contaminants that enter the water. Good vegetation cover will help prevent direct losses of fertiliser when heavy or intense rainfall follows fertiliser application – for example, pasture needs to be at least 25 mm high to be effective.

Much of the loss of phosphorus to waterways occurs in association with sediment or dung. These losses tend to increase if fertiliser is applied in late autumn or winter. Placement and incorporation of fertiliser will help reduce run-off in cropping situations.

\(^{22}\) A measure of the capacity of a soil to store nutrients such as P and S.
8.3 Fertiliser requirements for pasture

8.3.1 Lime

Most improved pasture species and particularly forage legumes are sensitive to acid conditions. Large inputs of lime are required initially and on an ongoing basis to maintain healthy soils. Chapter 6 contains information about liming of peat soils during cultivation. During the first 10 to 13 years of peat development, a total of around 30 to 35 tonnes per hectare of lime will have been incorporated to 200 mm depth. No further deep mixing of applied lime should be required. Maintenance dressings can be applied to the topsoil. To maximise productivity in peat soils, farmers should aim to maintain a soil pH of 5.0–5.5 in the topsoil (0–75mm) and 4.5–5.0 in the subsoil (75–150mm). As peat mineralises over time, the optimum pH will move more towards that of mineral soils (5.8–6.0).

8.3.2 Phosphorus, potassium and sulphur

Ongoing inputs of nutrients are required to replace the losses due to product removal, leaching and run-off. Soil and herbage tests are the best way to determine the quantity of nutrients required to raise your soil levels for optimum production. Testing avoids over-fertilising, which is an unnecessary cost to both the farmer and the environment. Table 8 shows the soil test ranges recommended for near maximum production.

Table 8: Target soil test ranges for peat.

<table>
<thead>
<tr>
<th>Target</th>
<th>Nutrients</th>
<th>Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Test</td>
<td>pH</td>
<td>Olsen P</td>
</tr>
<tr>
<td>Ranges</td>
<td>5.0* - 5.5</td>
<td>35-45</td>
</tr>
</tbody>
</table>

* pH of the subsoil (75-150mm) should be at least 4.5 – 5.0.

Sulphate is soluble and easily leached from peat soils. To minimise risk of leaching, single superphosphate should either be applied in one spring dressing or split dressings in spring and autumn. Elemental sulphur fortified single superphosphate also minimises risk as it contains slow release elemental sulphur.

8.3.3 Trace elements

Peat soils are deficient in a number of the trace elements required for optimum pasture and animal production. Copper is required for both pasture and animal production and selenium is required for animals. Inputs of boron are required for brassica crops. Some peat soils are deficient in molybdenum, while others have an overabundance. Herbage tests are the most effective way to monitor trace element levels in peat soils.

8.3.4 Nitrogen

Newly developed peats are very nitrogen deficient. However, once pasture is developed, the use of nitrogen fertiliser will depend on farm-specific economic considerations, such as gross margin and stocking rate, together with an assessment of current feed supply. Typically, pasture responses to nitrogen fertiliser depend on the time and rate of application, as shown in table 9.
Table 9: Effect of application time on peat pasture responses to nitrogen fertiliser25.

<table>
<thead>
<tr>
<th>Month of application</th>
<th>Kg DM/kg N applied</th>
<th>Response time (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>May</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>June</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>July</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>August</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>September</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>October</td>
<td>13</td>
<td>6</td>
</tr>
</tbody>
</table>

Pasture responses to nitrogen are largest and most consistent in spring. Direct loss of nitrogen fertiliser by leaching is greatest with winter application (May/June). If soils are saturated, there will be a slower pasture response to nitrogen fertiliser. Low soil temperatures also result in a slower pasture response.

Nitrogen fertiliser responses are lower on older pastures containing less vigorous pasture species (table 10). It is less efficient to apply nitrogen fertilisers to run-out pastures containing a high proportion of low fertility grasses.

Table 10: Effect of peat pasture age on the size of nitrogen fertiliser response26.

<table>
<thead>
<tr>
<th>Pasture age</th>
<th>Response to fertiliser N (kg DM/kg N applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old pasture on developed peat</td>
<td>8.7</td>
</tr>
<tr>
<td>New pasture on developed peat</td>
<td>27.3</td>
</tr>
</tbody>
</table>

Recommendation 13: Avoid applying nitrogen fertiliser in mid winter.
Direct loss of nitrogen fertiliser by leaching is greatest with winter application (May/June). Pasture responses to nitrogen are largest and most consistent in spring.

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25 Adapted from van der Elst, F.H. 1980a.
26 Adapted from van der Elst, F.H. 1980a.
References


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