Peat - Part 1 Version 1.9 20 May 2015

Peat was the first topic I wrote about in The Northerner in the 1960's, after our success with developing peat from raw swamp, some of which was 10 metes deep and so soft that it could only be crawled over. My thanks go to those who helped us with information, in particular the late Tony Donnelly who taught me that there was more to fertilising than NPK, to those who encouraged me to write, to those who checked and added to parts of it, and to those who wrote testimonials. They include Ian McDonald, peat dairy farmer client at Patetonga; Julie Pirie, a peat dairy farmer and ex top LIC consultant of Ngatea and clients Tony & Gwen Ashford, peat dairy farmers of Ngatea and Grant McGregor, peat sharemilker of Taupiri. Then there were Dr Clive Dalton, ex Waikato Polytech agricultural tutor, now a Technical Editor, Grant Titchiner, Water Engineer, Ecostream Ltd, Hamilton, and many more.

I wrote a 200 page book on peat in 1980 to correct old inaccurate research and add the results of my trials, but could not get it published because there were only 2,000 peat farmers, which was too small a market. The colour photos would have made each cost $100 or more - Chinese printing was unknown. However, it was just as well because this eBook has been added to and updated 20 times or more now to record improvements discovered.

There has been almost no government research into peat since 1955, but some farmers and some consultants have done their own, allowing all to benefit. GrazingInfo records more 'correct' research into peat than all others put together. Those who have not read this chapter quote 1985 research that has been superseded, and unfortunately is often miss-quoted to suit their aims. It is that surface applied agricultural lime on peat soils doesn't move down into the peat. This comes from one Department of Agriculture trial on undeveloped raw fibrous very poor Rukuhia peat, of which there is now none. Since then farmers have improved peat dramatically by applying capital dressings and regular amounts on the surface, increasing pasture and animal production to levels better than many soils, so peat liming, fertilising and management have changed since 1955. So-called scientists still quote it, and worse still do it on DairyNZ peat land on Lye Farm, which caused DairyNZ scientist Dave Clark to say at a field day they ran in 2011 that peat was difficult to farm.

When farming peat on Piako Road Gordonton I found that raw and rush covered peats needed capital application of about 14,000 kg of lime per hectare chisel ploughed in to at least 35 cm, and 3,000 kg spread on top before sowing new pasture on raw peat that was growing Manuka. Other fertilisers were also needed as a capital dressing of a mix of about 1,000 kg per ha of the best reactive phosphate and deficient elements of elemental sulphur, magnesium (Serpentine. See Elements > Magnesium), OrganiBor, copper sulphate, cobalt sulphate, zinc sulphate, and other low in pasture analyses, while clays and loams can improve with much less.

In the 1960s our pioneering correct treatment changed raw 10 metre deep fibrous peat growing Manuka to carrying 2.5 cows per hectare in two years.

There are 2,000 peat farmers in New Zealand, mostly in the Waikato. Because of DairyNZ, some are still suffering from the wrong information explained above and published in the 2010 Lincoln University Manual, and advised by all the 'establishment' namely Ruakura, MAF, AgResearch, DairyNZ, LIC and their consultants, and NZ fertiliser companies that want farmers to apply their fertilisers rather than lime.

I really appreciate the major input that my wife Auriel put into our farming, peat and GrazingInfo.

Here she is digging out roots and burning them. She also opened blocked drains, pulled out weeds, drove tractors, milked and more, then on our second farm chopping and picking up stumps, erecting 600 metres of Insultimber two wire electric fence a day, and, after selling our second farm, her work on our city investment properties and with whatever I did,

such as managing the NZ National Fieldays (she was secretary), consulting for Gallagher, DeLaval, and a dozen other companies. Without her hard work, skills, typing and editing, progress would have been very slow.

Introduction to Peat by Keith Thompson, University of Waikato.

There are about 260,000 hectares of peat in New Zealand, of which 200,000 are in the North Island (170,000 in Waikato) and 60,000 in the South Island, and some Stewart and Chatham Islands.

A hundred million years ago New Zealand was without the mountains, and fifty million years ago the earth moved and pushed the Raglan and Kaimai ranges up to well above sea level. Twenty million years ago sea over the lower areas formed the coal and limestones. One million years ago volcanic eruptions filled the low areas. A quarter of a million years ago volcanic ash from the central plateau formed the Hinuera stone. About 13,000 years ago peat started growing and raising water levels in the Waikato. Ten thousand years ago the Waikato River brought down large amounts of soil, depositing it south of Cambridge. These deposits explain why there is clay over peat in some areas.

In about 200 AD Taupo erupted and the Waikato changed its course completely at Hinuera, from where it used to flow to the Hauraki Gulf, to then flow north through the Waikato, and then west to the sea. The above dates vary between sources, which is no problem when it is only few decades.

Peat Statistics

Peat is dead organic material which forms at about 1.5 mm a year in the Waikato from moss, ferns and other anaerobic plants which grow and die and are preserved in the very wet, acid conditions. This process can continue for as long as there are surrounding hills to contain the water. Formed peat bogs retain their own moisture and build up in the centre of the swamp at a faster rate and for longer each year, forming an inverted saucer shape or what is called Dome peat. Shallow peat has a reasonable amount of soil and associated minerals through it, but deep peats have almost none. The trouble is that until farmers take pasture samples and compare them with soil samples and what is happening on their farms, they don't realise how inaccurate peat soil tests are.

There are peat deposits in Russia, Ireland, Finland, Scotland, Poland, northern Germany, the Netherlands, Scandinavia, North American states of Michigan and Florida (Everglades), Canada and other countries. The majority (around 80%) of peat lands are found in high latitudes. Approximately 60% of the world's wetlands are peat, which cover around 3% of global land mass or 3,850,000 to 4,100,000 km². About 7% of this total has been used for agriculture and forestry.

Under some conditions, peat will turn into lignite coal over geologic periods.

In Finland, 26% of the land area is bog of some sort and much is burned for heating and electricity. Peat provides approximately 6% of Finland's annual energy production, second only to Ireland. The contribution of peat to greenhouse gas emissions of Finland can exceed a yearly amount of 10 million tonnes of carbon dioxide, which equates the total emissions of all passenger road traffic in Finland.

Finland classifies peat as a slowly renewing biomass fuel, while the EU classify it as a fossil fuel. Ireland also burn much theirs.

This Peat information is in several chapters and is the only complete document on peat that I know of. It should help the thousands of peat farmers in New Zealand and other countries.

In the autumn of 1955, when, with very limited capital, I was looking for a farm, the only ones I could afford were peat farms, so I researched peat. At that stage NZ government research was very basic; however, thanks to the late Frank van der Elst, it was superior to current NZ peat research, which is non-existent. Frank was the government Ministry of Agriculture (MAF) peat researcher from 1954 until retiring in 1981. He used two blocks on the deep Rukuhia peat which was very poor, but my clients nearby have improved theirs with surface application of LimeMagPlus to be better than current MAF and DairyNZ shallow peat. He ran a variety of trials on drainage, liming, fertilising, pasture types, blueberries, etc. Since then no research has been done on peat, despite there now being 260,000 hectares of peat in New Zealand, and more than 2,000 peat farmers, some having won the Fieldays Farms of the Year competitons against all in New Zealand. As always the case in New Zealand, agricultural research finance was limited, despite agriculture earning half the country's overseas exchange annually.

In 1980 Frank complied "Soil Groups of New Zealand, Part 4, Organic Soils." It is the only New Zealand research book on peat. It was a low-cost photocopied A4 100 page publication, as a more costly

publication could not have been justified for the then 1,000 (mostly very poor) peat farmers.

Frank showed that 60 cm deep drains 20 to 40 metres apart (depending on the wetness and rawness) improved pastures, but 50 years later this is still seldom done, so after heavy rain one sees large areas covered in water. This then soaks down through the peat, leaching fertility to waste, and polluting underground water that eventually carries fertilisers to bores and/or rivers, while 60 cm deep spinner drains remove heavy rain as it falls.

Frank (everyone is known by Christian names in New Zealand) knew that peat had to have plenty of lime and fertiliser and be thoroughly cultivated, so, with his limited budget, he did a ten metre by ten metre plot thoroughly. When I visited it in the dry March of 1955, this plot was green and growing, and he explained how he achieved it. I was most impressed, because during the hot dry weather it was greener and growing faster than the supposedly better soils in the Waikato.

I asked Frank if there were good and bad peats. He said that there were, and that the deeper the peat the worse it was, and that the best at the time was on Piako Road, Gordonton.

As luck had it, I bought a 40 ha (100 acres) two metre deep, mostly raw rush and ragwort covered, peat on Piako Road from Alan Matthews for £4,500, NZ$450,000 equivalent now, but with improvements now worth three times that. It was his runoff for grazing dry cows and young stock. Alan was very helpful and kind and required only a £700 deposit. My parents lent me a few thousand pounds at no interest for the first year, to move on a cottage, build a farm dairy, and to buy cows and machinery, which consisted of a £250 Ferguson 28 and trailer to take the 20 gallon milk cans to the road. The rest (a backend fertiliser loader, buckrake and grader blade) I made at a friend's (the late Doug Matthews) farm at night, using his welder.

My second employer in 1955 for two months, the late Dolf Jensen, gave me an old fertiliser spreader I repaired, and my third employer also for two months (I was doing relieving work while searching to buy a farm), George Yarrall (both of Tatuanui), gave me an old mower I converted to three point linkage and used for ten years, and a hut to live in until the £450 (now NZ$90,000 equivalent) Ministry of Works one bedroom cottage arrived.

The Unfortunate continued use of old research

Some of the anti-lime information above originates from one Department of Agriculture trial done in 1954 that I saw in 1955 on very raw fibrous Rukuhia peat swam (some of New Zealand's worst peat), badly cultivated (mouldboard ploughed), with nowhere near enough lime or fertiliser applied and no earthworms, so it was dead. Also, in those days much of the lime was not finely ground so didn't move down. The lime used in the trials was hard and coarse, not the current softer finely ground Rorison's LimeMag (lime with synergistic serpentine and OrganiBor). See Elements > Calcium and Magnesium.

From the late 1950s on our two farms we were out-producing the government research one. To my knowledge no AgResearch or DairyNZ lime trial has been done on peat since 1954. However, scientists should see the good results many of the 2,000 peat farmers continue to get from surface applications, and quoted from trials and successful use, a dozen times in GrazingInfo.

In NZ in the 1950s, before metrics, the standard and widely used application rate by successful pasture farmers on most soils was 2,240 lb (1 ton) per acre of 97% calcium carbonate lime every three years, which is 2,500 kg per hectare. It worked well, so Waikato pastures then were better than in 2010 when poor pastures are seen on many farms and research centres. If sufficient lime has not been applied over the decades, a higher capital application will be needed on peat, pumice and other low Ca soils. Use pasture tissue analyses on all pastures to be sure. On well run farms, animal production per hectare in 2010 was double that of the 1950s, so a lot more lime is needed just to replace calcium leaving farms in milk and meat.

Testimonials

There are more testimonials in Testimonials, but this one relates to peat.

Ian McDonald, Patetonga, Waikato, wrote, "Our farm is all peat, five to six metres deep. Vaughan Jones became our farm advisor in 1991.

"I was most interested in his 'complete picture approach', using fertiliser recommendations based on his Pasture Tissue Mineral Analysis spreadsheet of 17 elements, and then Fertiliser Nutrient Planner spreadsheet, to give better soils, improved animal health and production and farm profitability.

"He took pasture samples each autumn. From the analyses Vaughan made his recommendations for

the fertiliser which we applied once a year (before the leanest pasture period). His recommendations are based around lime, Sechura or Gafsa reactive phosphate and trace elements - all slow-release ones.

"It was interesting to see the improving levels of elements in our pastures over the years.

"Our animal health improved greatly with the aid of Solminix soluble minerals (now called DeLaval FeedTech minerals) added to the water, as well as Selcote-Ultra in the fertiliser. We only had to treat two or three mild cases of milk fever or grass staggers out of 360 cows (later only one out of 500).

"Cow fertility improved, so we didn't induce or use CIDR's to encourage cycling.

"Profitability improved greatly: we had lower vet bills, better cow fertility and per cow performance of 423 kg (931 lb) milk solids per cow and 1,300 per ha (1,100 lb/a) from deep peat, some of which flooded. Soil condition improved as well, with greater numbers of earthworms evident.

"Hydrophobic dry knobs, that are common on peat farms, disappeared. The peat became softer and more friable, which allowed better rain penetration in the autumn."

End

Ian and Ann bought three neighbouring farms and built a beautiful retirement home and one for their family on elevated sections at Whitianga and bought a boat. Their son Paul now sharemilks 700 cows for them in a rotary on 246 ha.

Many other peat farmers have done extremely well out of peat.

Hydrophobic soils (not only peat) in much of New Zealand are increasing, mostly through a lack of LimeMagPlus.

Peat's Bad Name

Peat was a soil type that had a very bad name up until the 1960's, and still has with some. At a DairyNZ field day on their Scott farm in 2011 I heard their soil scientist say, "Peat is so difficult to farm". This is completely wrong. It is simply because they don't apply LimeMagPlus on the surface, because of the distorted reports on the 1955 trials.

The belief in those days was that peat was so slow and expensive to develop that the first three owners on any peat farm went broke. I was the third owner! Dolf asked how many cows it would be able to milk on the 40 ha. I expected to milk 60 (the national average herd size in 1955) within 20 years. This was based on other peat farmers' speed of development. This satisfied Dolf, but we passed 60 cows in three years, and were up to 90 in five years, bought two neighbouring properties, passed his production in 1964,, which was on top Tatuanui land, and milked 200 by 1966 (11 years).

In 1959, we won the most improved dairy farmer in the Waikato award, which was a week in Wellington with the NZ Dairy Exporter and NZ Dairy Board and the other provincial winners. Our production per hectare was higher than many on mineral soils, thanks to my learning by trials that 14 tonnes of lime per hectare chisel ploughed in to 40 cm, and earthen tonnes on top, were necessary to change Manuka covered ten metre deep peat swamp into 2.5 cows per hectare in two years.

The result was MAF bringing bus loads of peat farmers to see our farm, followed by a stream of individual farmers, so I had to charge, which started my consulting.

Peat

Raw peat is dark brown in colour, acid and anaerobic, mainly of partially-decomposed, loosely compacted organic matter with more than 50% carbon, that has accumulated in water-saturated peat with aerobic conditions above it. Its structure ranges from visible plant growth on top, living roots, dead plant material including sticks and large roots from old dead trees and partly decomposed plant remains. The warmer the climate, the more quickly the plants grow, and the more quickly they decompose once drained.

Prior to our success in 1959 many New Zealanders criticised peat as a poor pasture growing soil, however, after then things started to change. In the 1980s peat took another leap, after several dairy and beef farmers farming peat won the NZ Agricultural Fieldays most profitable Farms of the Year competitions - against all soil types.

No book has been written on proper farming New Zealand peat soils since 1980, and that one was based mainly on research on undeveloped raw fibrous Rukuhia deep poor peat, of which there is now almost none left. Since then, farmers have improved peat dramatically, increasing animal production to levels on a par with any soil in NZ, and better than many, so liming, fertilising, cultivation and

management have changed. There has been almost no government research on peat since 1985, but yours truly, some farmers and some consultants have done their own, and learned from it. Unfortunately tutors, lecturers and the resulting scientists don't use successful farmer information, only scientist paper theory, so New Zealand has suffered.

The history of peat development from the scrub in the photos below was that it would revert to rushes, and have to be cultivated and regrassed at least three times. In 1955 everyone said this, so I believed it.

I found that raw and rush covered peats need a capital application of about 17,000 kg of lime per hectare (ha) (15,000 lb per acre) chisel ploughed in to at least 35 cm (14 inches), and a capital dressing of about 100 kg per ha (90 lb/a) of phosphorus (P) in the best Reactive Phosphate (RP), while clays and loams can improve with less than half these amounts. We applied these amounts to Manuka (*Leptospermum scoparium*) and rushes, chisel ploughed, etc., and achieved pastures that didn't revert to the rushes which were expected on peat.

Many call natural P "reactive phosphate rock" (RPR), but it is powder, not rock, so I call it "reactive phosphate" (RP).

The finer it is the better, to make the maximum possible contact with the soil. Elemental sulphur, and other elements based on pasture analyses, also need to be applied.

Many write how fertile New Zealand soils are, but, except for pockets of alluvial soils, they are not naturally fertile - they are man made. In much of New Zealand the kg of P required to be applied per ha per annum per kg of milk solids (MS) produced is 0.08 for peat, 0.07 for ash, pumice and loams, and 0.06 for clays.

Farmers who recognise these requirements see dramatic improvements soon after buying peat farms, while those who don't just drift along, and sometimes blame their wet, raw or dry peat, for their low production.

Types of Peat

Peat is not like a mineral soil, it is mostly organic matter formed over thousands of years from a number of mosses, rushes, ferns, sedges, reeds and, in some drier areas, large scrub such as Manuka shown below. The vegetation grew and died from flooding and/or blight, then more grew over the older plants as the water level rose, caused by the newly formed peat slowing water movement. Shallow (one metre deep) peat has some soil and associated minerals through it, but deep peats (two to fifteen metres deep) have almost none at the top and are more acid than shallower peats. As peat swamps increase in depth, the fertility of the new peat decreases. New Zealand's deepest known peat is about 15 metres deep.

You should be able to get peat depth maps from your regional council.

The dead organic material increases in depth at about 1.5 mm a year in the Waikato, from plants that grow and die, and are partly preserved in the very wet, acid conditions.

This process can continue for as long as there are surrounding hills to contain the water. "Dome" peats (higher in the centre) retain their own moisture in the centre of the swamp, where they build up faster and for longer each year and through summer (NZ dry season) than the edges of swamps that dry out.

Peat is more inclined to form in countries where there are no prolonged droughts that kill off the anaerobic plants, and where there are no, or few, heavy animals that would slow down its spread, or even prevent it from establishing in the beginning by trampling the water holes that could otherwise start growing peat.

In 1990 a university peat tutor wrote, "In early stages of development of pastures on peat, rushes tend to grow, requiring frequent cutting."

This was the norm before 1957 when I proved that rushes wouldn't grow, and pastures would thrive from Manuka covered peat like this, provided sufficient lime and fertiliser were chisel ploughed in thoroughly, and about 3,000 kg of lime per hectare was applied on the surface and roller cultivated or harrowed in. If insufficient lime was applied, rushes would grow and need repeated mowing, pastures would weaken, become sparse and weedy, so need resowing after chisel ploughing, cropping and resowing again within a few years.

The same tutor wrote that it is difficult for a tractor to pull a mouldboard plough in very soft peat. These photos at the back of our first farm show how it was developed from scrub, so it never went

through a rush stage. It went straight to carrying 2 cows to the hectare, and 2.5 cows a few years later.

I crushed the Manuka with a rotary hoed (shown above) at about 6 km per hour to break down the Manuka, not to chop it up, then when dry in late winter, while the peat was still wet, burnt it. The hoe helped push the tractor, so there was no "pulling" which is what gets one stuck.

In the 50's and 60's the price for scrub peat land like that in the background was $50/ha. Today peat developed into top pasture costs $30,000/ha.

I made a chisel plough in 1959. The results were so good that I got plenty of contracting from farmers in the area. In the winters I made 12 to fill orders just on Piako Road, Gordonton, where our first farm was. Then I couldn't keep up with the demand, so in 1965 got Port Brothers Ltd at Kiwitahi making them. After they closed, Vogal NZ Ltd in Hamilton made them for us.

I got dozens of farmers to do comparative trials on other soil types and the chisel plough always grew better crops and pastures, so no one should be using anything else in any soils. However, most still do today, showing how long it takes for improvements to get through. The Dust Bowl in USA was partly caused by turning the soil over instead of just aerating it with rippers or chisel ploughs. See Cultivation > Malabar Farm. On company display stands at agricultural shows in USA in the 1980s there were mostly five chisel ploughs to one mouldboard plough.

The descendants of peat farmers will be interested to know that their farm probably looked like this in the 1950's. I don't normally have nightmares, but did in the first years on our first farm. In my dreams rushes grew so fast that they swamped me. The millions of rushes growing on our farm then, and returning on most peat farms, would have fuelled the nightmares. Rushes never came back on our farm because we drained, limed adequately with 17 tonnes per hectare and fertilised correctly, both with the trace elements that peat lacked.

The 170,000 hectares of peat in the Waikato are now developed high producing land, grazing nearly half a million dairy cows and other stock, and feeding humans with crops such as blueberries.

Developing peat was well worth it because our consolidated peat grew this two metre high chou-moellier in 1960. This photo of the NZ Dairy Board's excellent consulting officer, Peter Hildreth (right), and me was published by the NZ Herald and NZ Dairy Exporter.

Peat proved itself in that three Waikato peat farmers won NZ Fieldays Most Profitable Farms of The Year Awards in the 70's and 80's - against all soil types.

Analyses of Peat

Raw peats have a pH of between 4 and 5 with only 2 phosphate, 2 potash and no sulphur. Good mineral soils have a pH above 6 with 10 to 20 times more P, K and S.

The minimum pH for peat to grow good pasture is about 5.8, but over 6 is far better. The pH will be lower at greater depths. P should be between 40 and 80. You may be surprised at these high figures compared with mineral soils, but peat is so light that figures are high. I've seen P of 70 from raw dry peat. See P.

Analysing peat soil is not accurate, because it is not a mineral soil for which soil tests were developed. There has been no "soil" test system developed for peat, so it has no accurate standards, especially when using reactive phosphates, although the Resin P test appears to be better then

the Olsen P test for phosphorus (P).

Also peats vary in density and weight, depending on how long they have been farmed or consolidated.

Julie Pirie, who I believe was New Zealand's most experienced Livestock Improvement Corporation (LIC) peat consultant, and who kindly moderated parts of this, wrote, "Olsen P tests have caused me many problems. Some low fertility peats growing nothing but sorrel had an Olsen P of 60!"

So, on peat in particular, pastures should have the herbage analysed twice a year to calculate the fertilisers and trace elements required. The calcium level in pasture and a spade tell you more than pH . See the chapters on it and on Soils > Earthworms.

Mineral Content

Generally, shallow peats have a higher mineral content than deep peats. Those that have a high mineral content are much better than those with a low one. The high mineral content is from flooding off surrounding hills, by extensive burning and from being shallower. Peats containing minerals burn into a red brown ash, while those without minerals leave a grey ash.

Kahikatea Peat

Peat with large Kahikatea or white pine (*Dacrycarpus dacrydiodes*) and other large stumps is shallower than Manuka (*Leptospermum scoparium*) peat, because the trees were growing in mineral soil. They could not grow large in pure peat. Peat containing stumps is very expensive to develop, especially if there are several layers of large stumps and logs. However, the peat in these areas is of better quality than that developed from Manuka.

Kahikatea trees would have been growing before the peat swamps rose, and then would have fallen over as they became drowned, and, once the peat became too deep and wet, no more Kahikatea trees would grow.

If you have these on your farm (they are frequently close to mineral soil level), try to slow the consolidation (decomposing) of your peat, because when you get down to them they are **very** expensive to remove and leave soft holes and uneven peat. Incidentally, the stumps don't rise, the peat decomposes down around them.

Pasture over stumps that are just below the surface will be poor, and stop growing in dry weather, because pasture roots can't go down and moisture can't come up. The solutions are to remove the stumps, or in some cases grind them down. Grinding and/or chipping is expensive and usually has to be done again within a decade, but saves having to heap and burn them. Chipping turns the peat into dry fine powder, so apply lime before chipping, and grow and graze an annual ryegrass with clovers in winter, and Shirohie Japanese millet or Nutrifeed in summer, to get the structure back. Kahikatea peat is not as acid as Manuka peat, so needs less lime.

When large numbers of Kahikatea stumps are present, it could be cheaper to use an excavator to dig them out and heap them. The larger and higher the heap, and the more peat it contains, the longer it will take to dry out before burning is possible. More smaller heaps are cheaper to make, dry out more quickly, burn better and are easier to make and clean up afterwards with a farm tractor.

Manuka Peat

Manuka peat is the most common. In the middle of Woodlands Estate at Gordonton in the Waikato where peat was about 15 metres deep Manuka grew to only about two metres. After peat is drained, Manuka will grow much taller, especially near the drains.

Pastures on deep peats are generally much poorer than on shallow peats, and don't last as long before needing re-cultivating and re-sowing.

Manuka even six metres high can be knocked over with a tractor and crushing bar and a rotary hoe skimming it to just crush and kill it at about 8 km/hour without chopping it. The hoe pushes the tractor so getting stuck is less frequent. If done in summer, it can be burnt in late winter, spinner drains put in at about 30 metres apart, then limed and hoed, and chisel ploughed several times, before fertilising and sowing.

Pumice Layer

Many ask about the thin pumice layer in peat. It came from the Lake Taupo eruptions between AD

130 and 185, when ash was deposited fairly thickly over the pumice area and to a thickness of a few centimetres over much of the Waikato and Hauraki Plains. The layer of pumice in the peat is noticeably thicker close to it and thinner 150 km away. Two to three metres of peat then grew over it. On the hills the pumice was washed off the steep parts, both close to Taupo and further away. On the less steep and flat areas the fine pumice that travelled 100 or more km by air became mixed into the soil. See Soils > Pumice.

Peat that has been cultivated frequently since extensive peat development started in the 1950's has sunk and had this pumice layer mixed in, whilst peats that have not been cultivated much still have it at various depths down to a metre.

Substrata

Peat that is lying over sand or pumice becomes over-drained if drains are dug into the porous material. Neighbours' deep drains into porous material, and cracks in over-drained peat, can over-drain adjacent areas. That is because the coarse sandy pumice moves the water so fast that it can drain it from a long distance.

This can develop into a serious problem. In the middle of last century in central Africa agricultural engineers organised the clearing and draining of large peat swamps for cropping, by digging 2 to 3 metre deep drains that removed the water from under the peat faster than it could be replaced from rainfall. The result was the complete drying out of the two to three metres of peat that blew away and ruined the area for agriculture. Over-draining has ruined peats in many countries and in some areas of the Waikato. They can become hydrophobic (water repellent). Lime helps fix them.

Peats that are over clay or marine silt don't dry out as much, and, when consolidated and then cultivated to include the marine silt, turn into highly productive soils with lower fertiliser requirements.

Learning about peat

Peat is not like a mineral soil. It is mostly organic matter. Peat is called "muck soil" in USA, and in the past many things in New Zealand! Until the late 50's it used to be considered so costly to develop, and so slow to respond, that the first three owners would go broke. Techniques improved - one was three point linkage Ferguson tractors and then rotary hoes, but only limited research has been done in New Zealand.

Many mineral soils are fairly forgiving of mistakes such as pugging or over-grazing, but peat is not. However, peat only pugs when it has thin, poor pasture in under-drained conditions, and/or is treated really badly. Because it doesn't pug like clay soils, most of the pasture grown on peat can be consumed, whereas that on heavy clay can have up to half or more pushed into the soil by grazing animals in wet conditions.

Examples of how well peat farmers can do were Lornie Brothers at Orini, who won the NZ National Fieldays Beef Farmer of the Year Award in 1979, farming 1,100 dairy beef bulls on 407 ha of peat, some of which was 4 metres deep and still fairly raw.

In 1990 the National Fieldays Most Profitable Dairy Farmer of the Year was Gary Seath, Tenfoot Road, Whitikahu, north east of Hamilton, farming 67 ha of peat, the deepest of which was 1.5 metres. He milked 200 cows for 74,000 kg of milk solids, or an average of 370/cow and 1,100 MS/ha 17 years ago. The stocking rate was 3 cows/ha, giving an EFS, that is the gross income before salaries and interest, of $2,555/ha. Using 2007 figures, and deducting the home and section value, the EFS would be over $4,000/ha.

It is interesting that, despite the 'establishment' accusing winter ryegrasses of attracting and feeding Argentine stem weevil, Gary Seath over-sowed his whole farm with Concord every autumn with excellent results (won Fieldays Farms of Year), high production and no Argentine stem weevil problems. On our farms we also grew winter ryegrasses every year with no Argentine stem weevil problems.

Many successful farmers were not doing what the establishment were recommending. For example Gary Seath also fully fed his heifers for most of their lives, resulting in them being as large as most farmers' mature cows at calving, and with a condition score of 5.5.

Both the above winning farmers beat others on so called 'good land', many in better summer rainfall areas than Orini and Whitikahu, which suffer summer droughts because they are in the centre of the Waikato, which doesn't get the summer showers from the east or west. Other peat farmers have also

won awards against all soil types.

Another peat success example was Hamilton's late Len Reynolds, who bought one peat farm and ended up in 1999 a multi millionaire, owning three peat farms and many commercial buildings. These people showed what could be done with peat, and that, instead of being a costly venture, as claimed by many, it was highly profitable.

"How did they do it?" This eBook aims to show this and be a practical guide to the management of all stages of peat, from raw to the fully improved.

Criticism of the 'establishment' is not of all scientists, but of the system run by bureaucrats.

Few people go into commercial businesses without training such as apprenticeships, or working for good companies to learn, but many take up farming without the experience they need, and many farmers buy peat and start farming it without knowing its requirements. I was sometimes asked to come to a peat farm because production was low and not increasing, even after 40 years of owning and farming it. Mostly the problem was that nowhere near enough lime had been applied at sowing and subsequently. Unfortunately too many remember another wrong statement from research results that, "lime doesn't move down in peat".

Reasons for this statement were -

The Rukuhia peat was raw, fibrous, layered material that didn't allow lime to work down. 90% of peat is now not like this.

It was very wet so water movement downwards was not great.

It was "dead". This means it had no soil life in the form of earthworms, soil organisms and humus, which is decomposed organic matter.

Cultivation was with a mouldboard plough that just turned the peat over and didn't mix the lime in, as is done with a chisel plough, that became the most successful cultivation method in the 70's, but is still not used by all. Mixing in the lime makes the peat like potting mix, instead of inert bog.

New pastures on newly developed soils and new peat have to have animal manure, poultry manure, effluent or artificial nitrogen (Ammo or sulphate of ammonia - NOT urea which lacks sulphur. Read Elements > Nitrogen) to get established with ryegrass deaths. Most new pastures on all soil types need nitrogen until clovers produce it.

Successful peat farmers applied lime regularly on established pastures as recommended for mineral soils, which was 2,500 kg/ha every three years. The best peat farmers applied more, and it did work down, despite their being told by ancient theorists that it would not. The LimeMagPlus made pastures produce more and last longer, saving cultivation and resowing costs. Earthworm numbers increased and facial eczema spores decreased to as little as 10% on many of my peat clients farms.

Unfortunately some have still not learned even in 2012. This photo of peat dug up in 2007 and held in the air, at the DairyNZ Lye farm, shows horizontal roots because of shallow cultivation and insufficient lime.

Dangers of not understanding peat

Not understanding peat is a major problem. Full knowledge of any type of farming is imperative for maximum profit. It is not advisable to farm any land until you know most about the type of farming you choose. Some think that they can go farming without training. Farmers' sons can be the worst. Too many leave school and go straight on to their parents' farm. Today, agricultural college or university education is imperative. An understanding of the technical side (fertilisers, milking machines, etc.) can make the difference between making a profit and not making one. Farm profit margins are too slim to cope with mistakes. After education it is best to work for a few top farmers before going on the family farm.

Piako Road farm

The farm had 1.5 metre deep boundary drains which were over-draining the peat, so within a few weeks of buying the farm I changed their shape from slow-running narrow, dangerous for animals, deep drains, which needed manual cleaning (no hydraulic excavators then - only expensive draglines), to one

metre deep and three metre wide fast flowing V drains. These, once consolidated, could be grassed and grazed to the bottom so seldom needed cleaning, which could be done with a tractor grader blade, and later with an offset spinner drain digger (see below) we invented and made, with Auriel chipping my welds and doing the painting. The one metre deep drains didn't over-drain the peat. The neighbours didn't like what I'd done on their boundaries, but a year later they experienced the benefits and filled in their own deep drains. Not only was the peat good on Piako Road, but, as with most Kiwis, so were many of the neighbours.

Getting stuck

Getting stuck, like this neighbour did, occurred even in the 1970's. Sometimes it took two tractors to pull one out, and sometimes the pulling tractors couldn't get much grip in peat. Once we had to borrow 100 metres of cables and chains to reach the drain bank from where we could get traction. Seven hours later we had it out. The boy driver had fallen asleep rotary hoeing, and allowed the tractor to veer into the hoed ground and dig in.

Tying posts in front of the back wheels with a thin chain (avoiding the valve) and then climbing up on to the posts was often the only way, but the front of the tractor would lift, so "manpower" was sometimes needed to give the front weight. Digging the cross post in a bit made it easier to climb over, scrub then had to be cut and spread in front of the wheels and over the softer areas.

I can't remember how many times our good neighbour Archie Raitt pulled me out of the bog, because there is only one way a tractor driver learns how to drive on peat, and that is to get stuck a few times, and then to learn to avoid treacherous areas - and treacherous they were. You could be cultivating rush and Manuka (scrub) covered areas quite safely, and suddenly the tractor would just go down to its axles, and if you didn't stop immediately it would dig in deeper. Light tractors were assets on peat. We had a Ferguson 28, then a 35 then a 65, all light relative to their power.

Archie warned me not to spin the wheels once the tractor stopped moving forward, and to come for help. What was disheartening was when returning with Archie and long chains and sometimes cable to pull the tractor out, I would be horrified to see that the tractor had sunk further just with its own weight in the soft bog. Archie would say, "Gee, that is deep", and I would explain that it had sunk further on its own. Fortunately he knew this happened. Between five minutes and seven hours later we would have it out.

To reduce the problem of tractors getting stuck, we put eight wheels across the back, as shown here with an offset spinner drain digger. The two outside tyres were free damaged ones with no tubes and were mounted on a 4 mm flat wheel that I got rolled, and then welded a 25 mm by 4 mm rim to the outside edge. The very outside tyre had only one bead on the rim. This design made the extensions cheap and avoided leverage breaking axles. Our Fergusons (we had five contracting over 11 years) never broke an axle (or pto), while some brands did.

Our neighbouring peat farmer John Ball on Woodlands Road, Gordonton, fitted large wheels onto the front of his tractor, and I made fertiliser spreaders with large wheels like this one.

Raw Peat

Our first forty hectares had no peat deeper than two metres, and the peat had a bit of body to it, because most of it had already been cultivated by two owners. After a year, twenty hectares of raw scrub covered peat behind our farm was auctioned by the

local county council because the owner, who had gone back to England, had not paid the rates.

The outstanding amount was £90, so at the auction I bid £100, (NZ$200 worth about $10,000 now) and, although there were about twenty people there, no one else bid, so we got it for five pounds per hectare, when the going rate for land in the area was £25 per hectare. It was completely undeveloped, and was so soft that when I walked over it before buying it I sank up to my thighs only forty metres from the boundary drain.

Fitting the tractor with a total of ten wheels (see photo) allowed me to drive over this very soft land, but, if I did get stuck, I would have to get it out on my own by having the tractor crawl up over a post that I carried on all implements. Fortunately, by rotary hoeing a few hectares, and putting in spinner drains (shown) every 30 metres (see Soils > Drainage for more), we got the 20 hectares into grass over four years, without any major catastrophes. This peat was half way to Woodlands Road, and was ten metres deep. A child could push a six metre length of 20 mm pipe all the way down into the peat. It needed an adult to pull it out.

The water table was a foot below the surface in summer and on the surface in winter, so it was still growing the Manuka, rushes and moss that make peat.

Light mineral soils dry out in dry periods, and in the typical winters heavy clay soils become so wet that half the pasture can be lost through pugging, whereas peat, correctly surface drained, with one every 30 metres (100 feet) in some wet parts, chisel ploughed and well farmed, has none of these problems. It will now grow as much pasture as any soil, and allows all to be grazed without damage. If correctly farmed it doesn't dry out as much as some in our dry summers, and three peat farmers won against all farmers the annual NZ Fieldays Most Profitable Farms of the Year award when it was run from 1970 to 1990.

Peat Fires

There are still many areas of Manuka and scrub covered peat in New Zealand and there are vast areas of over-drained peat pastures, all of which become high fire risks every summer. There are also over-drained peats that can burn at most times of the year.

There are peat reserves that can be permanently destroyed if fires are allowed to start and spread. For those unfamiliar with how easy it is for peat fires to start and spread, the danger areas include -

Most peat soils at any time of the year, with a much higher risk in dry weather.

Lightning strikes over raw undrained dry peat which emits methane, a highly flammable gas. See the photo below.

Under trees where peat becomes very dry.

Drain banks which become dry to a deeper depth.

Hay paddocks, and where dry grass or weeds are longer than when grazed efficiently.

Deferred grazing pastures, before or after grazing.

Roadsides.

Along railway lines.

Heaps of rubbish.

Children who light fires - and get burned in them.

Even with the best intentions of all concerned, fires start in some areas each summer, and controlling them by rotary hoeing, which I pioneered and many Waikato farmers used, is being lost simply because peat fires are now not as common as when six could burn at the same time as shown in the photo below.

Most of the peat swamps have been developed, so we don't suffer the annual stenches of peat smoke which penetrated everything, including one's home. However, we shouldn't think that fires are a thing of the past - a bad peat fire in the Melville area burned for several months in 1987, and another about four

years ago. The smoke was so thick that it damaged computers in the west of Hamilton, not to mention its effect on personal health. One near Te Hoe in February 1998 cost $100,000 in helicopters and water pumping without putting it out. Rotary hoeing could have done so in a day, rain did later. After reading about it I phoned the farmer. It had burned for seven weeks. Had he known about rotary hoeing, the cost would have been minimal, and the fire would have been put out in days, and the hoeing would have gone part way towards cultivating for regrassing the area.

Most local bodies have by-laws which prohibit the lighting of fires through summer. Some such as Hauraki require fire permits all year. However, a closed fire season doesn't stop fires from starting. They can start from peat or grass sticking to tractor exhaust manifolds and other farm vehicles, then falling off after becoming alight from the heat. Engine driven farm machinery should be washed daily when in use on peat in summer and when making hay. On peat farms, a shovel should be carried on all engine driven machines.

On leaving a peat paddock after cultivating, making hay or just driving around in summer, one should look back for the tell tale blue wisps of smoke.

Fire watching in summer, even on consolidated peat farms, should be a regular procedure, as is done from lookouts in forests. Equipment should be on the ready because the stitch in time rule applies with peat fires. A new, small surface fire, of about one metre diameter can be put out in minutes with a shovel by digging deeply around it to stop it spreading and then digging it over deeply until smothered. When larger and deeper it can take days, or be rotary hoed about three times until smothered. The hoeing must be done within a day. More than one hoe would be needed for a large area. A contractor with a hoe costs a small fraction of a helicopter, which is less effective.

Often I've heard of farmers going for water to fight a small one metre diameter peat fire. When they returned half an hour later (it takes time to get drums filled with water) the fire had spread across the paddock because dry grass had caught alight. If they had had a shovel with them, the job would have been done in minutes. Instead they cost thousands of dollars to put out, repair fences and regrass burnt areas.

Fighting peat fires

If dry pasture or scrub on peat does start burning during a fire-ban or dangerous period, controls should be implemented, and it should be reported immediately to the local council fire officer. Again, time is of the essence. All the controls described should be carried out as soon as a fire is noticed.

In countries such as South Africa where veld fires occur annually, fire breaks are burned well before the dry fire season. Early morning conditions are best when there is dew and no wind. Most farmers will burn breaks with neighbours along boundaries, and across farms and around buildings, hay stacks, etc.

In non-peat areas, if a fire can't be stopped by using normal methods, because it is burning in trees, scrub or in other highly flammable material, it could pay to back-burn towards the fire. This is done when a wind is blowing the fire towards an area or buildings which need to be protected. The method is to start from an existing fire break such as a drain, lane, road or one installed for the purpose by mowing, blading or burning one during a safe period. Before doing so, check with authorities and tell your neighbours. Back-burning is done by lighting along the oncoming-fire side of the break and allowed to burn against the wind. It must be lit right on the edge so that flames are small and low. When fires burn against the wind they are smaller and easier to control. Fire also travels very slowly against the wind, so keep this in mind when planning it to stop an oncoming fire. If the existing natural fire break is not wide enough, it can be widened by cultivating or blading flammable material off the surface. Fires being fanned along by wind cause sparks to leap ahead, increasing its speed of travel and its jumping distance.

Back to peat. If drains are flowing, outlets should be blocked to raise the water level. Flammable items such as stacks of hay, should be moved to prevent a larger fire developing, which could spread sparks over a wide area. Long dry grass, weeds and scrub should be cut and removed from at least a 50 metre radius - small summer whirlwinds which abound in hot conditions around fires can lift burning material and carry it 50 metres very easily. If the fire is already crossing a dry grass paddock, rotary hoe, spade hoe, power harrow or blade the grass off well ahead of the fire and then rotary hoe back towards the burned area. Don't feel that you are killing your pasture, because the fire will kill it anyway. Hoe the burning areas repeatedly, until the fire is completely smothered.

One might wonder how hoeing peat would put it out, but peat is like coal - stoke a coal fire too much and it goes out by smothering itself. To achieve this in peat, the hoe should be set as deep as possible and the peat chopped finely. The hoe's tail flap should be down and weighted slightly to compress and reduce the amount of air in the peat. Do the whole burning area once, then bad areas several times, then wheel roll them to exclude oxygen.

Hot dry peat burning a metre deep can't be hoed with a normal wheel diesel tractor, so it is imperative that hoeing starts immediately, before the fire burns too deep.

Areas with large stumps can't be hoed, so extra care must be taken to avoid fires entering these areas. An excavator can be used to dig deep holes into moist peat and bury the burning peat. Otherwise use a shovel to dig a deep trench around the burning area and monitor the trench by throwing burning peat back into the fire from the trench. If you don't have access to a hoe, and plan to let the fire burn itself out, be very careful at the edges. Disturbing edges where fires stop can make it start burning back under the ash which will have dried out a few more centimetres of previously wet peat.

Water has little effect on large areas of burning peat, because the tremendous heat generated evaporates the water, however, small areas can be flooded if adequate water is available.

Peat can continue burning under ash dampened by rain and even under water, so be aware of this and monitor burning areas at least three times a day until heavy rains fall and the steaming has stopped.

In Indonesia where they get heavy monsoon rains, some peat has been burning up to three metres deep since 1982 (15 years) during a severe drought. They had flooded many of the areas, but satellite monitoring still detects hot spots, showing that peat was still burning under the surface. Authorities are not sure how deep. They see trees falling over around it so know that the fire has burnt under them. Subsurface peat fires are treacherous and difficult.

No one would want the above things to occur on their farms, so care must be taken to prevent fires and to avoid conditions which could dry out peat to make it flammable, such as over-draining.

When drains are not much deeper than a metre, sub-surface burning is unlikely and surface fires can be hoed out, but when drains are two metres and deeper, the fire risk is substantial and extinguishing is more difficult. The cracks in dry peat allow air to feed the fire. Hoeing fills the cracks and smothers the fire. Several hoeings will be necessary.

Many animals have had to be disposed of after suffering skin and udder burns after sinking into hot steaming peat even after the fire was out. People and livestock should be kept away until the paddocks are regrassed. Remember that this applies to dogs too.

Animals walking across a smothered peat fire can start it burning again underground by pushing hot ashes into the peat below and allowing air in to the lower levels, and the animals can be severely burnt.

Peat fires over the years have caused considerable damage, so should be treated seriously. Petrol tractors have caught fire and been ruined, so when fighting fires -

Don't use petrol tractors anywhere near burning peat.

Ensure tractors are in good condition and have sufficient diesel to not run out.

As the tyres go round watch that burning sticks don't get stuck between lugs.

Have help, including people wearing long gumboots, a spare tractor, posts, chains or long wire ropes, shackles, pins and shovels. If you have to go for help to pull out your stuck tractor, there may be only ashes by the time you return, so always have a shovel on board to dig a trench around it.

If a tractor gets stuck, spin the wheels to remove hot ashes, remove hot peat from under and around it and dig a trench around it.

Peat fires need visiting three times a day until the burning area stops steaming.

If the peat is overdrained, so is bone dry for metres down, the burning embers from a small fire which starts should be carted away to a safe area, which may be in a water trough (it can be cleaned out later), a metalled (gravel) farm lane, the tanker track, a clay area, or concrete, but even then, burning peat should not be left where wind can blow it to somewhere flammable.

People are not the sole causes of fires. When digging in peat I have seen the black remains of burnt sticks over a metre deep from fires nearly a thousand years ago (1.5 mm of peat growth each year), so possibly from lightning.

Treat peat fires with extreme caution, and best of all prevent them starting. NEVER burn anything on or near peat during the fire-ban period, or at any time before dry weather is due. Inform all your family and staff about the above dangers and extinguishing techniques annually - we all forget.

Some farmers in the past, and one I met recently, believed that burning peat improved it. If it is over-drained it may improve, but after good peat is burnt one has to start again with no topsoil.

When growing maize during the change back to pasture on the 107 ha Puketaha peat farm we bought, which was in maize, we found that in the first three weeks, seedlings on the black peat grew double the height of those on the peat which was brown from being burnt decades before. We analysed the plants and soils, and later found that the only difference was that the spring soil temperature was higher in the black peat. The brown peat was colder in spring, and had no benefits, despite having mostly brown ash, which has a higher mineral content and is better than the low mineral content grey ash.

In February 1956 in a few hours a fire came across the three metre high Manuka killed by blight from Tauhei, four km away, and showered sparks that burnt seven hectares of our first peat farm, from our left to right boundaries, including our summer turnip forage crop. We couldn't get access to about 10 hectares of our pastures, beyond the fire, or to 20 hectares of hill at the back of the farm. We didn't have a rotary hoe then, so Auriel and I tried in vain to put out the hundreds of small fires with shovels. Rotary hoeing puts out (smothers) peat fires in very little time.

We were milking only 28 cows. The fire nearly broke us, so Auriel, who is a shorthand-typist secretary, offered to work in Hamilton, half an hour away in our 10 hp Ford Anglia car, and I went agricultural contracting. Both saved the day, because it gave us money to buy food and put into the farm, which remained a bottomless pit for the eleven years we farmed and improved it. Auriel was always a great help in everything I chose - farming, manufacturing, Fieldays, Gallagher, DeLaval, consulting, etc. She milked the cows after work while I did agricultural contracting, developing the peat for neighbours around the back of our farm until dark, and I continued contracting until 1966 on a variety of peats and soils. This increased my farming experience and I developed the unique way of extinguishing peat fires by smothering them by rotary hoeing. This technique is still hardly known, partly because problem peat fires now hardly ever occur, instead of several times every summer as they did until the late 1960's. See Fires.

Dolf Jensen's prediction of disaster was coming close, but Alan Matthews again rescued us by ending us a further two hundred pounds, 100 to buy the 20 hectares in the undeveloped swamp behind our farm, and 100 to keep us afloat. Eleven years after buying the farm, we produced more milk than Dolf Jensen did on his slightly smaller good clay farm at Tatuanui, east of Morrinsville in the Waikato, and by then peat was beginning to be recognised for the wonderful soil type it is.

This photo is courtesy of the late Ada Reynolds, wife of the late Len Reynolds who developed and owned several peat farms in the area. These six peat fires burning in the 1960's are in the partly swamp area between Piako Road and Woodlands Road (shown on left) between Gordonton and Morrinsville. The whole area in this photo is now mostly dairy farms with good pastures shown in the next photo.

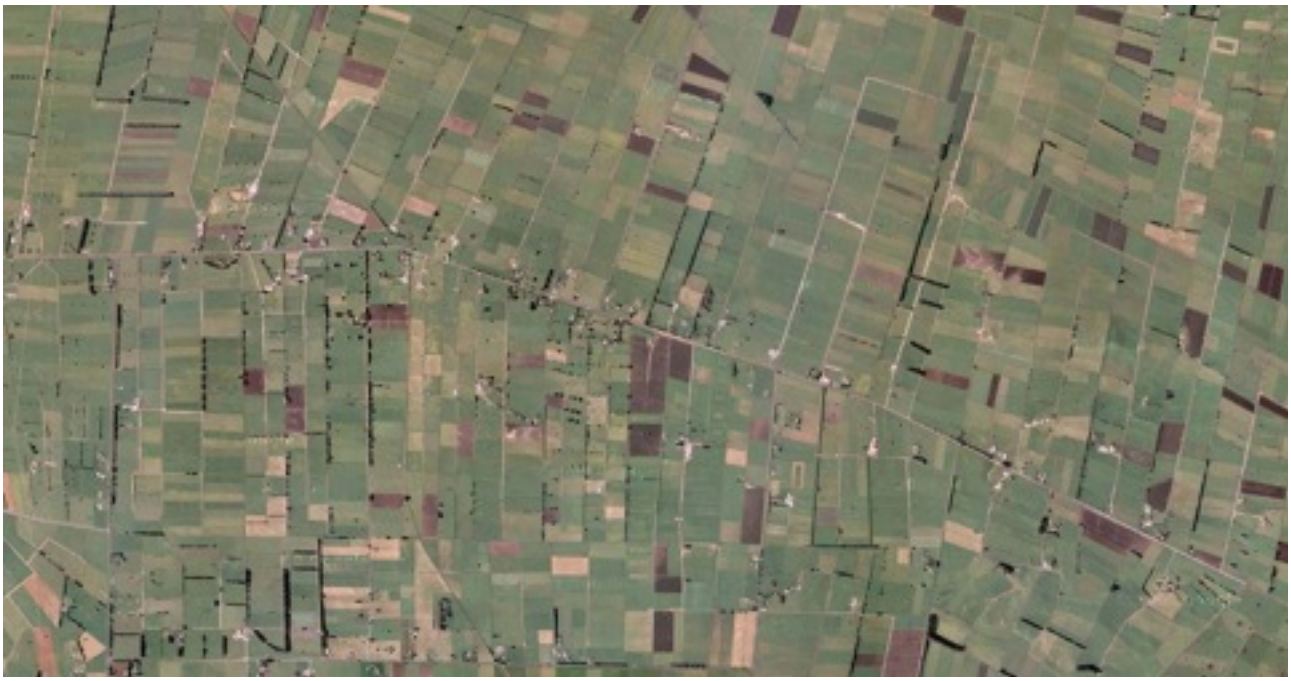
The fire in the foreground started by a piece of hot ash dropping off a tractor exhaust on its last round before knocking off for the day. By morning it had spread. The dark colour around the burnt square on the left is from the farmer digging up the wet peat to stop the fire spreading. It was allowed to burn all the top of the other paddock so that it would not have two levels in it - one wet and one dry.

Hamilton, Waikato, is about 10 km below the photos.

Fires were a worry until the 1990's, before when half a dozen could burn in the swamp at the same time in summers as shown here. Woodlands Road, from Gordonton is across the top left of the front fire, and down the centre of the 2010 photo below. Peat fires used to rage across the swamps every

third or fourth summer. This was the time it took the Manuka to grow, be affected by a blight which killed it, and then be highly flammable, and of course there was always a fool around with a match or cigarette butt to start a fire.

Lightning could do the same, as proved by charred wood I found metres down, below the Taupo

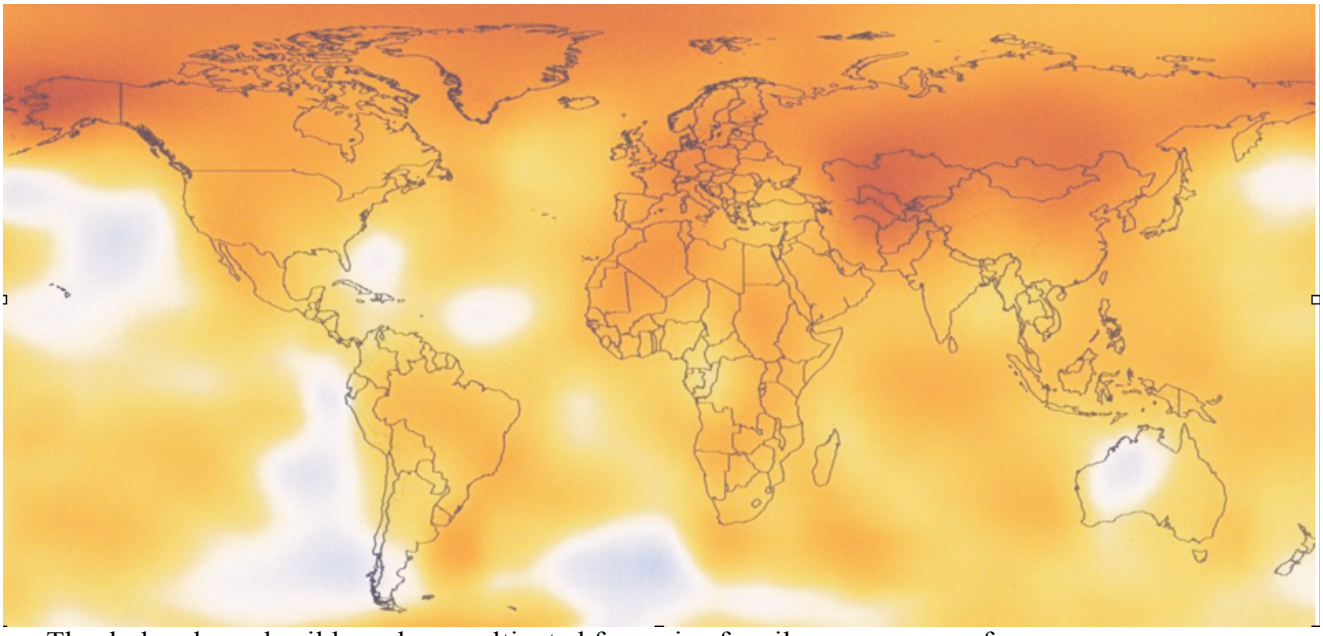


pumice layer in the middle of the Woodlands swamp, perhaps two thousand years before.

New Zealand ruminants are accused of causing pollution from methane in their breath, but the amount was calculated from USA grain and silage fed animals, not pasture grazing ones that produces less methane.

Swamps emitted a lot more methane before they were drained, than the animals that now graze the pastures grown and shown above in this spring 2010 satellite photo in the same area as the fires above 50 years before. Anyway the total amount of methane produced in New Zealand is nothing compared with the world total. See the Pollution chart below.

Our first and second farms were in this area where the peat was two metres deep on Piako Road and to ten metres deep on Woodlands Road.



The dark coloured soil have been cultivated for maize for silage or summer forage crops.

The peat with a mineral content became light brown, like clay burns when making bricks, and the peat without mineral content, from the middle of the swamps, burned a grey colour, like the ash from paper or other pure organic materials.

When we saw the fires coming across the swamps, we did everything we could to protect our own farms from burning, but were seldom successful. In the hot dry Februaries even pastures growing on peat would burn. Fortunately most of our peat was then not over-drained because we had filled in the deep drains, so the fire burned only the top 20 to 40 cm. However, next to the back two metre deep Drainage Board drain, it burned holes 1.5 metres deep and left a mess. Rains finally extinguished it in late winter. The fire in the correctly drained area was contained, and regrassed in autumn. Excessively deep board drains were a costly problem for the 29 years that we owned that farm.

After fire burned the previously cultivated and dry peat off the top, the moist peat underneath couldn't carry livestock, and in some cases not even tractors, so we couldn't move our livestock across the burnt area to the pasture at the back of the farm. This cost us dearly, and resulted in our producing only 1,000 kg of milkfat in 90,000 litres of milk in the first year from 28 cows, some of which got burnt in the fire, because we didn't know to fence off the burning peat areas to stop inquisitive cows walking in there and sinking to their udders. In 1956 we were inexperienced in fighting peat fires, as were the neighbours, and we didn't own a rotary hoe.

A neighbour's daughter was badly burned when she fell through safe looking peat topsoil which had been undermined by burning peat. It was drained too deeply.

Development

I designed and made a chisel plough, and chisel ploughed in 15,000 kg of lime/ha (15,000 lb/acre) and applied capital fertiliser rates (both nearly double AgResearch recommendations) to reduce the frequent and costly regrassing that underfed peat required, and to carry 2.5 Jerseys/ha (1/acre) and replacements by 1960. We were broke, so could develop only 2.5 hectares properly in the first and second years, then ten hectares each year.

In 1960 Auriel and I converted the farm dairy to the country's first straight-rail, 60 degree herringbone farm dairy (milking parlor), milking 98 cows in an hour on one's own. Cows could walk in and out double file. I later designed one for the dairy farm at Massey Agricultural University in Palmerston North, the Waikato Polytech and for many farmers.

The NZ Dairy Exporter magazine and NZ Dairy Board consultants selected a dairy farmer from each province to visit the Dairy Board's operation - NZ Dairy Exporter and LIC, then in Wellington. I was excited to be chosen from the Waikato and written about in The Exporter.

Following this, AgResearch and LIC consulting officers would bring groups of farmers to see how we had gone from 28 cows to 90 in four years on what had been a poor peat runoff. Peat farmers would ask me to visit their farms so I had to start charging. Consulting and contracting grew rapidly so we engaged a sharemilker.

NZ Dairy Board consultant Peter Hildreth had been running our peat discussion group, and doing a wonderful job. Later, I resigned from the group because too many were not doing the things necessary to farm peat correctly, and yet continued to blame peat for all their own failures.

Auriel and our three daughters hated the inedible weeds that the cows wouldn't eat, such as ragwort, so would go with trowels and bags and dig them out. When we left the farm to retire, there was hardly a weed on it. Adequate LimeMag, trace elements and fertilisers help. Pennyroyal and chickweed won't survive when adequate lime is applied.

Edible weeds such as docks and rushes (Juncus) were left to provide variety, but the farm ended up with none because animals ate them for roughage and variety from the lush pastures.

Another thing which irritated me was the frequent statements by other farmers that they could not do the same because of their soil type, despite peat being condemned by most people as the worst possible soil in New Zealand in the 1950's and 60's, and by some still.

What irritated me in particular was that two of our farm discussion group were ex-Ruakura technicians, who knew everything except how to make a profit. Their production per cow and per hectare were the lowest in the group by a long way, but even in those days they insisted on milking more cows, for less profit. Even now, forty years later, this organisation emphasises production per hectare, and not much else, despite high stocking rates, to achieve this, increase pasture damage and animal ill health, not to mention farmer and family stress.

In 1966 we leased the farm out for a few years through a Morrinsville consulting company which failed, and then had Lynton Simmons sharemilk for us on a fifty-fifty basis for 11 years, after which we sold it and bought a larger peat farm.

Many times we were told by visitors, sales people, etc., visiting our farms that we had a good piece of land, as if it was naturally good. I tolerated this for a while, then would ask if the good land, shaped a quarter of a km wide and 2 km long, was there waiting for me?

Our two farms each became the best in their areas, thanks to doing just ordinary things that anyone can do, such as putting in 17 km of shallow surface spinner drains on the first farm of 89 hectares (220 acres) at a current cost of only $100 a kilometre ($160 a mile), no field tiles or underground porous plastic piping that is incredibly expensive, doesn't last forever and doesn't work until the soil is too wet, and then leaches elements down the drain. Also, applying adequate lime chisel ploughed in, and applied on the surface at least every two or three years, intensive subdivision, good water supply, weed control without spraying (See Pastures > Weeds) and balanced fertilisers based on pasture analyses.

This was thanks to Tony Donnelly of Nutrilink, who taught me that there is more to fertilising than soil tests and NPK. This was in 1982, but in 2007 the vast majority including AgResearch and Dexcel still farm 25 years behind many, and 50 years behind their own research.

In the late 1950's New Zealand government agricultural scientist Ken McNaught studied the benefits of tissue testing, and wrote that measuring pasture is far more reliable than measuring soil. Winchmore Irrigation Research Station in the South Island (see Elements > Phosphorus and Pastures > Analysing Pasture Tissue) and many other New Zealand research figures confirm this, as did my findings when consulting for 200 farmers in several countries. Their own Overseer computer program developed to help farmers fertilise correctly doesn't even use the far more accurate pasture analyses for the main elements, and especially for trace elements.

Our First Farm (1955 to 1984)

The photos below tell their own story. Left of the tanker track is the front right paddock. Right of the track is a neighbour's. How the neighbours can't see, and fix theirs, is beyond me. The soils were 2 metre deep peat at the front of the farm and 10 m at the back. The left foreground is our front left paddock. On the right is our neighbour's. The foreground is our front left paddock. Behind it is our left neighbour.

This photo was our back paddock we developed in 1960 from the Manuka seen at the distant back. The near back had been disced by a neighbour, which was not effective without lime. The peat here was 8 m deep. By 1990 the whole swamp was in pasture, mostly in dairy farms. The original pH was 4, so it needed 17 tonnes of agricultural lime per hectare chisel ploughed to 30 cm (12 inches). This and a 1,000 kg per hectare capital application of correct fertiliser grew pasture as shown, without rushes that lesser amounts of lime and fertiliser gave on almost all other peat developments at the time.

There are still a few areas of peat to be developed, and there are large areas of peat that were cleared and sown in grass, but not very well, so need doing properly, and there are some areas that reverted because they were hungry and badly managed. A lot of peat is not being farmed to capacity, because some farmers don't realise that doing everything correctly gives a good financial return. An example is

that it is usually better to crop and/or resow a smaller area correctly, than a larger area inadequately. The well done area can keep improving for decades and may not need doing again for a long time - provided it is managed correctly.

Lack of finance is sometimes blamed, but this excuse should never be used, because the improvement that can be achieved by using known techniques gives excellent returns on the investment within a year or two. This fact should influence farmers to spend money on improving small areas properly to give a profit, rather than doing large areas poorly and unprofitably.

When doing agricultural contracting on peat between 1955 and 1966 in the Gordonton, Puketaha, Morrinsville and Rukuhia areas, I learned a lot from seeing peat treated in every conceivable way. In all cases the well-treated areas improved and the farmers thrived, while many poorly treated peats (and other soil types) pulled their owners down.

People, by nature, often look for complicated solutions to simple problems, so solutions take longer to become clear. Some problems occur where peat is farmed by newcomers who don't realise that there are major differences with peat, because it is not like conventional mineral soils.

Peat is too often accused of some incredible faults, mostly to justify mistakes that owners have made, sometimes quite unwittingly, because of no knowledge of what should be done. Peat which is less than about two metres deep and farmed correctly soon becomes one of the best soil types for grazing in pasture, and is easy to cultivate and farm. Deeper low-fertility peat takes longer to become as good, and needs more frequent resowing after it consolidates.

Another important point is that farmers who do well are often those who do EVERYTHING on time, i.e., applying lime and fertiliser, feeding soluble minerals, treating animals for parasites (which is not as often when also feeding the best soluble mineral mix in the water), sowing crops and renewing pastures, making good silage or hay, cleaning drains, fixing fences, repairing anything broken, selling and buying animals ahead of the mob to benefit from better prices, and drying off cows at the best time. I have noticed that there is sometimes only a week between good and not so good farmers in getting things done at the best time.

Buying a Peat Farm

Before signing up to buy a farm, make sure that you check everything. It will be too late after you discover that it floods, has underground stumps, etc. Peat is different. Learn everything you can about peat before buying a peat farm. Over the years hundreds of peat farmers have had to walk off their farm with nothing - don’t join them. The last one I knew of was in 1987 and it was shallow consolidated peat.

Ask all local consultants, attend local peat discussion groups (more than one) and visit the best peat farmers in the area. Listen to their stories. One farmer’s big surprise on his new soft peat farm was that, after off loading his cows into a paddock - there was no ramp - they became spooked, and cantered around wildly until exhausted. After they stopped running the peat stopped waving and the farmer realised that it was not an earthquake causing the ground to shake like he had never felt before and frightening the cows. He had only heard about peat, but knew nothing more.

Paying too much can break you, especially if interest rates go up. Some have failed after going into new unknown soils, and even new areas, including several Kiwis going farming in Australia. One didn’t know that southern New South Wales could be badly affected by droughts. Selling up and moving cost him half a million dollars.

Annual costs on peat are higher than on good mineral soils because of the higher lime, fertiliser, draining, cropping and regrassing costs. Despite this, if done correctly, peat can give more profit than hill country, heavy wet clays, and even more than some of our best soils.

Before deciding on buying a peat farm, ensure that there is not something being done by a neighbour, or that you plan to do, which could cause friction or financial losses to either of you. Here is a suggested check-list. Ask if your neighbours are doing or planning any of these -

Over-draining their peat, causing it to sink more quickly, so could over-drain yours. It could also become a fire hazard.

Lowering peat levels rapidly by continuous cropping or frequent re-grassing, so that deeper drains will be required, which could then over-drain yours.

Growing large trees such as gums close to the boundary, because they will shrink the peat and over-drain it, which became a very severe problem for a farmer growing blueberries next to it. Gums next to

a drain can blow over and be costly to clean up.

See Drainage and other suggestions that are throughout this eBook about buying a farm.

The farm you are considering buying could be affected by any of the above, which could affect neighbourly relations, so, before inspecting the farm concerned, visit ALL the neighbours within two farms in all directions and tell them you are looking to buy a farm. Their farms might be for sale and could be better than the one you are considering. If anyone tells you that the one you already know is for sale, reply that you know about it and have checked it, and ask what they think of it. If you don't do this then those telling you may feel you owe them something for telling you about it. If they don't mention the farm you are interested in, ask them about it.

You could be making a multi million dollar investment, so need full information, before you buy, not after, so ask about -

Problems in the area, such as water quality (get an analysis of that on the farm you are buying), flooding, over-draining, bad weeds, vandals, thieves, pests, actions of neighbours and their effects on the farm you are investigating. See above.

Rainfall patterns, because there are summer-dry areas such as the middle of the Waikato, which misses out on rain from the east and west in summer.

Diseases in the area such as tuberculosis (TB) and Johne's disease.

Depth of peat, height above sea level and possible future drainage problems. Will pumping be necessary in the future? Peat Depth Maps are available from regional councils.

Town water availability. Access to it can be a bonus.

Contractors available.

Services available and those lacking.

Get the water tested for problems. It may need filtering, which can be a high cost. If necessary ask neighbours and the local well drillers about water quality in the area, and whether better water can be obtained. See the chapter on Water.

Get one or more pasture tissue samples (17 elements) depending on the peat types. You need to know the fertility and mineral levels of what you are buying.

Negotiate a lower purchase price on the basis that you will buy and apply or arrange for the application of the autumn fertiliser before you take over. A capital dressing is likely to be needed. This can then be worked out from pasture analyses, putting you a year ahead. If you don't arrange this, the fertiliser may not be what is needed and/or may not be applied at all as set out in the agreement, and how can you check? Use the VJ Pasture Analysis and VJ Fertiliser Order spreadsheets.

If you are unsure about something, ask several people about it, not just one. What may not worry one person may worry others - and may affect you.

See the dairy company statements about grades. Check with local bodies that the farm operations are legal, including buildings, drains, domestic sewerage systems for homes, water use, effluent disposal, etc.

Check that all buildings have permits, especially for additions. Once bought, you become liable, not the builder or previous owner. Once you own the farm all faults of all kinds become your responsibility. If you don't fix them to council requirements you can be prosecuted. If you discover legal faults just before possession, get quotes to fix them and hold back more than enough to repair them.

In the first year you won't need unexpected costs. If you are unsure about a safety aspect ask a Ministry of Labour Occupational Safety and Health (OSH) officer to visit the farm with you. A standard LIM report is useless. Buildings can be substandard, burnt down or even removed, but the LIM report will not tell you, because no inspections are made. Getting building plans allows you to check the buildings to see if all are legal and didn't have additions without permits. Ask the vendor and councils for all correspondence relating to the property to and from the councils concerned. Under the Freedom of Information or Official Information acts in New Zealand, you are entitled to it.

Peat farms to avoid are those with large areas that have large stumps, unless the price per hectare allows for them. Pockets of stumps around hills can be handled within a normal farm budget, but vast areas can't. Dig deep and/or use a 12 mm push rod in several areas because under some peats there are forests of stumps. Look for the tell-tale heaps burned or to be burned, and ask neighbours about stumps in the area.

When buying a farm, you are buying the soil first. Soil can make, or break a farmer, especially if too much is paid per hectare for a hungry farm with shallow topsoil.

Location is second, the buildings third and the fencing last. A good farm will pay for buildings and fencing in time, whereas good buildings on poor peat (stumps and very fibrous raw deep peat) will show little profit. Take a spade and check the soil in most paddocks as you walk the farm.

Most shallow (under 2 metres deep) peat, farmed correctly, is one of the best soil types possible for pasture and grazing, and is easy to manage, provided it is done correctly. Consolidated peat is an excellent pasture-growing medium, which is easy to graze in wet conditions, cultivate and drain. Pugging on consolidated properly drained peat is minimal, so in wet weather animals are able to eat most of what is grown, compared with about half in soils that pug easily.

If necessary, apply a capital dressing of lime and fertiliser over most of the farm and you'll be amazed at the improvement in many cases. Using a soil analysis for peat is a waste of time and money and is deceptive. Extremely poor hungry dry acid peat can show a pH of 5.8, but still need lime, and a soil P level of 60 or more and still need P, because peat being so light gives a false figure when dried, and minerals are measured on a weight basis.

Most peat in New Zealand is now in pasture and is used for grazing. Other uses are growing blueberries and maize. Growing maize for grain is a bit like the New Zealand car assembly industry was - much more costly here and at risk of cheap imports. If you plan to buy a cropping farm and put it in pasture, be aware of the very high costs in doing this, including fencing, roading, and reticulating water with troughs, and control of bloat, which can be severe, because perennial ryegrass dies out in the low organic matter soils after cropping, increasing bloat.

Before buying the neighbour's farm or a bigger one, *s*ee Buying Farms.

Please now read Peat, Parts 2, 3 and 4.

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