Cultivation

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Cultivation by chisel ploughing deeply brings up valuable subsoil, makes deeper topsoils and deeper plant roots, and grows higher yielding plants, with the bonus of reduced leaching of elements into underground water because the deeper plant roots are able to access more nutrients before they leach to below the root level. This is organic farming is not promoted.

The heading "Cultivation" should really be "Chisel ploughing" because it is mostly better than other forms of cultivation as will be explained. Dozens of comparative trials in many soil types that I've organised around the world, have always shown that chisel ploughing improves soil depth and structure, and the yields of subsequent crops and pastures are higher than from other types of cultivation, especially

"no cultivation which doesn't last long before users give it up". This would not apply in pure pumice or pure sand, or in soils with only a few cm of topsoil, in which case chisel ploughing should not be deeper than twice the depth of the topsoil, because doing so would dilute the topsoil too much.

Much of this chapter is aimed towards helping to extend the grazing period, which is much cheaper than mechanical harvesting and feeding, all of which are not profitable. Therefore aim to grow forage crops for grazing during summer dry periods, and where possible during winter lean



periods. 1.5 metre high kale ready to graze in early winter in Canada. Millet, Pasja or Nutrifeed can be grown in southern summers and grazed at 60 cm every 18 days in dry conditions.

To justify the cost of cultivation and growing forage crops, the yields must be high, so this chapter aims to show how to achieve top yields of crops and pastures.

Subsoil

I did this trial in preserving jars with one ryegrass and one clover seed in local Hamilton clay loam soil. The left jar was all topsoil, the next 25% subsoil, the next 50% subsoil and on the right 75% subsoil. As with rock dust, subsoil contains elements we don't even know about, but make clovers grow faster and be healthier. This shows how clovers need the minerals in subsoils, and ryegrasses need organic matter. Look at the clover roots grown to the bottom of the right



jar. I've seen nodules 35 cm (14 inches) deep in correctly farmed soils. On farms good clover growth can be achieved by chisel ploughing. Ryegrass can also be encouraged by chisel ploughing to create deep topsoils.

This better clover and grass on the edge of a road in Hamilton shows where a trench was dug for telephone cables 25 years before, bringing up subsoil. The trench went along the edge of the road and then right to a house. The topsoil was not deep.

I and many others have seen many examples like this, of clover doing better where subsoil was present, sometimes where pipes have buried across parks.

Clovers decreasing is a problem on some Waikato farms because of insufficient lime, too much urea, shallow cultivation, giving acid top soils lacking minerals.

It is a waste of time cultivating soils for pasture improvement, when the original pastures were run out due to growing in the fertility-mined top 15 cm of soil, poor drainage, insufficient lime and or inadequate fertilisers. All

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deficiencies must be corrected, often with capital dressings of LimePlus which is lime and the needed

fertilisers based on a ryegrass analyses.

Rock dust

Waikato farmer Gordon Stephenson grew two crops of maize for silage. One was fertilised conventionally and one with much cheaper rock dust from a local quarry. He told me that yields were about equal. Obviously this wouldn't continue indefinitely, because phosphate in quantities greater than that present in rock dust would be needed in the future.

He didn't chisel plough. I wonder how much better the fertilised maize would have been if chisel ploughed to bring up subsoil minerals - and benefit from deeper cultivation allowing deeper maize roots. These roots are from a chisel ploughed paddock that had to be dug out, our garden, then a mouldboard ploughed, which just pulled out with one hand.

What is in rock dust? Minerals, some of which were in the topsoils before people farmed (mined) the top 15 cm of soil for years, causing situations such as



the American dustbowl which made some farmers leave their farms and go west to fresh bush burnt land. Louis Bromfield proved organic conservation on his Malabar farms in Ohio, USA, which are an historic exhibition attracting 200,000 visitors a year.

New Zealand, being a very new country geologically, has shallow acid topsoils and is low in calcium and fertility except for a few alluvial areas near Thames and near Whakatane. When settled by Europeans, the Waikato soils were so poor that wheat could only be grown for two years in the soils benefitting from the burned bush. The large trees were harvested and the remainder cut burnt, which provided minerals. In the third year the crops failed, until lime and fertilisers were able to be bought. Bringing subsoil up by chisel ploughing is much cheaper than buying rock dust, which doesn't last.



Observant farmers have noticed that animals being moved along roadsides or lanes grazed the grass hungrily on the sides where gravel or metal lay over the soil, and then were forced into a paddock of lush grass just stood without eating. Calves are more likely to do this because they are selective grazers and growing, so need the minerals.

All of the above shows that there are necessary minerals below the 15 odd cm of mined topsoils, which chisel ploughing can bring up more cheaply than buying rock dust.

I've even seen tropical grasses in Queensland, Australia, growing far better where some subsoil has been brought up on formed storm water diversions (contour banks), and seen better pastures on roadsides in many countries because subsoil has been spread over roadsides, which are also not harvested or depleted from harvesting. I've seen clover growing much better where subsoil had been spread from a parking lot, than in the rest of the paddock.

Deep Chisel Ploughing

At my request, a <u>grazinginfo.com</u> member Owen Baker did trials on his farm near Matangi in the Waikato. The lush pasture on the left was after chisel ploughing. The poor pasture on the right was mouldboard ploughed at the same time. Using a PastureGauge[®] he measured the growth and his chisel ploughed pasture yields were



double those of mouldboard ploughing and of rotary hoeing, and with no bloat. On the mouldboard ploughed paddocks several animals died from bloat. Owen worked in town, and one day his wife phoned him to say the heifers were blowing. He asked her to move them to the next paddock, but she said that it had more and longer clover, to which he replied that it was chisel ploughed so they won't blow on it. Unknown subsoil minerals and higher Na and Mg levels in analysed subsoil, are our only explanation for

less bloat.

The mouldboard ploughed on the right shows grass and clover roots not going below the plough depth because of aluminium and/or a lack of organic matter and fertility. Note the poorer pasture in this paddock which was right next to the chisel ploughed one below. Both were cultivated at about the same time and the photos were taken within minutes of each other. All other treatments were the same. When the mouldboard spade spit was turned, it stayed in a lump.

Mouldboard ploughing in early spring brings up lower temperature soils, so delays the sowing of warmth-loving plants such as maize. It also buries the aerobic soil microbes and exposes the anaerobic ones, which is all wrong.

It and the chisel ploughed soil below were dug with the same 22 cm (8.6 inch) long spade.

Owen's chisel ploughed soil on the right below was crumbly, mixed and friable. Note the good pasture.

Disc ploughing, while better than mouldboard ploughing, is nowhere near as good as chisel ploughing. I've seen mouldboard or disc ploughed paddocks revert to a weedy compact condition, and rotary hoed ones more so. Digging into soils which were mouldboard ploughed have shown lime still in a layer upside down, with large clods of dead soil in the middle because lime was not mixed into

it. Ploughed down vegetation was in a layer, which restricts root and moisture movement up and down. Clover roots with large nodules and more earthworms were in the lime layers, but in all the chisel ploughed area.

Rotary hoeing cultivates to a shallower depth and can damage the soil structure, causing the soil to become compact. Ruakura Research Centre, then Dexcel, then AgResearch had rotary hoed for turnips and got yields of only 5 tonnes per ha (4.5 tons per a) instead of 12, and caused shallow rooted pastures. Peaty soil on the DairyNZ Lye farm was held upside down to photograph it. The new roots (white) at the top were growing horizontally at 15







cm (6 inches) because of cultivation to that depth, and no lime below it and not enough lime above it. Aluminium is not a limiting factor in this soil type. The fibrous peat shows that lime is needed. There were

almost no earthworms, which is another sign of a need for lime. This only one earthworm that we found had so much soil stuck to it that it was almost dead just through a lack of lime. Read Soils > Earthworms.

The practice of chisel ploughing is increasing rapidly in countries and areas that do a lot of cultivating, because of the saving in tractor time, and the better results achieved by deeper cultivation without inverting the soil.

The third time chisel ploughing of a paddock can include rolling as shown here. Harrows can be fitted between the chisel plough and roller. A 42 kW (60 hp) four wheel drive tractor is being used.

Additional benefits of chisel ploughs

Cheaper and quicker than other systems and little setting up and no operating skills are required, except that it must be set level both ways.



Most of the topsoil is left on top, and most subsoil is left below, except that they are both mixed to the degree required.

Existing horizontal layers are broken up and cracks are filled, allowing faster moisture movement both up and down.

The warm surface soil is not all turned down and the cold soil not all brought up, so planting can be done sooner in spring, and even on the same day as commencing cultivation. If the complete cultivation operation can be finished in that time, there will be fewer or no weeds grow.

Deep chisel ploughing moves lime and reactive phosphate down, which reduces aluminium toxicity at lower levels and makes the reactive phosphate more available. Aluminium stops the roots of some plants going down, and increases ryegrass pulling.

Deep cultivation brings up minerals that clovers need, and animals like. Note the improved clover growth that occurs where subsoil has been brought up, trenches have been dug, etc., showing that there are minerals we don't even know about, but which have been depleted by many years of farming the top 15 cm (6 inches) of soil. Sir Bruce Levy (Grasslands DSIR director) noticed in the 1930's that clovers did better in subsoil, and I have noticed this all round the world. Read GrazingInfo > Pasture & Crops. Soil and pasture tests I've done have failed to divulge the reason, showing that we still have much to learn about elements in soils. Do a comparative trial on your farm.

Some of the fertile topsoil is left on top, which allows seedlings to establish more quickly.

Incorporates plenty of warm spring air, mixes the turf and lime in thoroughly, and leaves an aerated crumbly structure.

Allows fertiliser to be applied first and mixed in. Mouldboard ploughing fertiliser in is not recommended. Most fertilisers are better mixed in, but with lime and boron mixing in is far better.

Correctly designed and well made spring loaded chisel ploughs outlast other types of ploughs.

When soils are wet, it is much easier to continue the cultivation operation after chisel ploughing than after mouldboard ploughing, because there are no furrows, and no sods of turf slipping from under wheels. Cultivation is right up to fence lines.

Chisel ploughing is like a million earthworms going through a paddock, which encourages subsequent earthworm activity because it doesn't kill any, and gives a more friable, deeper soil with better moisture retention. Soils chiselled deeply retain moisture better than soils cultivated in any other way. Earthworms are then more active in those soils.

Having some vegetation on top which protects the soil from the sun, which -

- Dries it out.
- Burns up humus.
- Kills surface soil microbes that hold soil particles together.
- Turns soil to fluffy powder, which is then hard to consolidate.
- Reduces caking, rain and wind damage.

Vegetation protects seedlings from cold and hot winds, however, too much vegetation, especially maize stubble, can act as an insulator and slow down the warming of soil in spring. Strip grazing the stubble short reduces this problem. Minerals need to be fed to the animals in the water because maize is very low in these. Read Forage Crops > Maize.

Procedure

To get the best out of chisel ploughing, it is important to carry out the following, if possible using a four wheel drive tractor. Choose the worst paddocks to crop and/or resow.

Use them as sacrifice paddocks to avoid pugging good paddocks in wet weather, and to avoid overgrazing and pasture-pulling in dry weather.

If unable to do the above, then in spring, about a month before the sowing date, start grazing the paddocks short by using the paddocks to be cultivated as sacrifice areas with on-off grazing, or let the cows in each day after milking, until the end of milking. If necessary, a little hay or silage in the paddock will encourage them in. After the end of milking let them into their normal paddock.

If unable to use animals, then mow the paddock, and, if the vegetation is not treated as above, cultivation will be more difficult, and, if by a contractor, more expensive, and a good seedbed will not result, unless an expensive, soil structure destroying and earthworm killing rotary hoe is overused.

If couch or similar troublesome weeds are present, spray to kill them, starting several weeks before cultivation, and then spray areas which are not thoroughly killed a second time, at least ten days before cultivating. If sprayed and left long enough for the vegetation and roots to die, no surface cultivation will

be necessary, saving an operation. When there is no option, using safe sprays, like Safety guard that I've used for 22 years with no problems. Don't worry abut the very strict rules on the bag, taken from dangerous sprays.

If there are no troublesome weeds such as creeping ones like a twitch or couch (Don't buy a farm with them), then rather than spray, use a tandem disc, rotary hoe or power harrow shallowly (70 cm), travelling quickly so as not to destroy the soil structure and earthworms. This breaks up the top crust. Doing this in the afternoon rather than in the morning will kill fewer earthworms, because they go down then, and rise over night. Some weed seeds germinate after being exposed to light. To reduce weeds in crops, some organic growers in Germany cultivate at night without a rear light on the tractor, or during the day with the cultivation equipment covered with black plastic sheets to prevent light getting to the soil. A chisel plough is easy to cover.

Killing the vegetation as described above allows a chisel plough to make a better job.

Shape the paddock by pulling off drain banks, filling hollows and mounding around gateways and troughs. You may need to do more levelling after the first chisel ploughing. If a large area is bared from shaping, sow it with a fast growing winter grass, such as an Italian ryegrass and a clover, after autumn rains fall.

Use a rotary drain digger to put shallow surface drains through low areas and along every fence line on flat land. On hill country install them on the contour sloping to a valley or dam to catch runoff, prevent erosion and excess rain running down the sides of hills from paddock to paddock. Many soils can cope with the rain that falls on them, but not with runoff from higher areas running on to them. Doing the above allows cultivation to start earlier in spring, especially in wet conditions. Wet paddocks grow weeds that survive in the wet, so drain them with several shallow spinner drain diggers.

Apply the amount of lime required on the surface, before the first chisel ploughing. If it gets wet it can be impossible for lime spreaders to spread on cultivated paddocks, so applying it before cultivating ensures that it is applied. Digging into soils under crops frequently shows that, where lime application and cultivation have been inadequate, there are pockets without lime and with un-decomposed turf, so make every endeavour to apply enough lime, and to chisel plough thoroughly and deeply. Clovers, high producing pastures, earthworms, soil microbes and livestock need ample calcium well mixed in.

After chisel ploughing twice, spread the fertiliser. It is important that lime and reactive phosphate (RP) are applied in separate applications as described above, as mixing them, drastically decreases the plant availability of RP. In dozens of trials cultivating fertiliser in has given far superior yields with all types of soils, summer forage crops and pastures. If applied after the cultivation and there is little rain, as is common in summer, the crop roots will not go down into the soil where there is no fertiliser, and the crop will hardly grow, but the low fertility weeds will. As well as lower yields, crops will show drought and deficiency effects earlier. Use the Trials spreadsheet for accuracy.

This right angle turning method of cultivation saves turning 360 degrees, and chisel ploughs the paddock twice. Start at one corner and go at a 45 degree angle to the far side, turn a right angle and go at a 45 degree angle to the first side. If the paddock is a long one, turn a left angle, and keep doing this to the end then work back doing the same thing until all is chisel ploughed twice. The final chisel ploughing should be round and round, to leave the paddock smoother in the way it will be harvested and fertilised.

Some modern chisel ploughs can have cultivator tynes and a bar roller attached (see photo above), so that after going across the paddock two or three times it is ready for rolling and sowing. It saves having to own a rotary hoe or power harrow. The three chisel ploughings take about the same time as one mouldboard or one disc ploughing.



If you have a tractor with enough power, attach a Cambridge roller packer behind the chisel plough at the final chisel ploughing. This will save an operation and give a surface that is easy to pull the fertiliser spreader over, and ensures that the fertiliser is spread on to an even surface, not on to a ridged one, which causes the fertiliser to accumulate in the bottom of each depression, rather than be spread evenly across the surface.

After chisel ploughing, roller cultivate the fertiliser in, and Cambridge roll until the seedbed is firm enough for sowing. Dual wheels on the tractor help compact the soil.

To bulk up the seed for an even spread, mix the seed with dampened lime, sand or safe fertiliser that won't burn. Boron, copper, potash and/or superphosphate all burn seeds. Broadcast the mix on, or use a drill. With pasture seed it is best to cross drill to get a more even spread, and to prevent the seedlings competing with each other, because some will then die which is a waste of seed and money. Roll to pack the moisture around the seed.

Avoid destroying the soil structure by over-cultivating and ending up with a powdery soil, as occurs after repeated rotary hoeing or power-harrowing, which also kill earthworms, lead to a fluffy and then compact soil which restricts water, air and root movement, and makes it dry out more. It takes years for such a soil to come right.

If the soil is very wet, improve the drainage with more small shallow drains, rather than a few deep ones, and chisel ploughing over a period helps dry it out without damaging it. If you are not planting a crop don't worry about a few pasture plants surviving. They add to the feed and make the change from pasture to the crop easier on the animals. See Forage Crops > Maize.

When soils are dry, or likely to get dry, cultivate small areas to be able to start one day and sow the next. Losing moisture ahead of dry periods from prolonged cultivation is losing money.

Sowing should be the day after starting cultivation. A major advantage of a short time between starting to cultivate and sowing, is the fact that weed germination will be less and will be slower than whatever is sown. I've seen differences on the same paddock of almost no weeds in turnips sown within two days of starting to chisel plough, and 80% weeds in an adjacent turnip crop in the same paddock, sown two weeks later after further cultivation. It was done to stagger the sowing. If staggered sowing is needed, stagger the cultivation by not starting until the day before the sowing day. If large, do it all in parts of the paddock.

Frequently the cultivation to improve pastures is so bad that pastures are worse after than they were before, and/or they don't last. Mouldboard ploughing and especially rotary hoeing are the worst at creating problems and short-lived pastures.

The aim with pasture improvement should be to end up with a pasture that will last forever, except for drilling in or over-sowing new improved species, as and when it is profitable to do so. To achieve long lasting pastures, thorough and deep chisel ploughing in adequate lime and correct fertiliser must be done at the time of establishing them.

No-till

Unfortunately some people with vested interests (selling drills, etc.) write as if no-till is always better than cultivating deeply. If they compared no-till with rotary hoeing or other shallow cultivation methods, rather than DEEP chisel ploughing, they could get favourable results.

Farmers who have tried no-till cropping often go back to tilling after a few years.

When cultivating before sowing forage crops (maize, millets, brassicas, etc.) and pastures, chisel ploughing is essential. In some stony soils cultivation is impossible, but there are some stony soils that can be chisel ploughed lightly. If, however, all it does is bring up more stones without the benefit of bringing up subsoil, deepening the topsoil and mixing in lime, then fostering earthworms, including Terrestris, is even more important. See Soils > Earthworms.

Under these conditions it is more important than ever to farm with the aim of improving and deepening soils. This is done by having good drainage, applying lime (if needed based on ryegrass analysis)

Proper cultivation with a chisel plough usually costs little more than spraying or no-till, but gives much better cleaner (no toxins organic results).