

Strip Tillage Farmer Guide

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A reduced-cultivation system for field crop production



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Second Edition

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Developed by LandWISE under SFF Project: "Controlling the Strip"

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Introduction

This Farmer Guide is based on research completed by LandWISE through the “Controlling the Strip” project. Funding was from the Sustainable Farming Fund, Hawke’s Bay Regional Council, Foundation for Arable Research, Horticulture NZ, Watties and McCain Foods.

Wind erosion and soil degradation have been identified as significant issues facing cropping in Hawke’s Bay and other regions of New Zealand.

Conservation tillage – retaining residues for soil protection – is widely practiced around the world. Strip tillage is a form of conservation tillage.

General Principles

Strip tillage combines advantages of conventional cultivation and no-till while avoiding some problems of those systems.

Strip-till involves cultivating narrow planting strips while leaving much of the paddock uncultivated. Generally, less than half the soil is cultivated under a strip-till system.

The cultivated strip creates optimum tilth and allows conventional planters to be used to sow the crop and helps ensure even germination.

The uncultivated ground prevents wind and water erosion and maintains soil strength. Uncultivated soil is more able to support vehicles (reducing compaction damage) and provides better traction.



Second year strip-till maize

Strip-tillage can maintain yield and soil quality, and reduce cultivation costs, in particular through saving fuel and time.

LandWISE Strip-Till Research

LandWISE began trialling reduced cultivation as a wind erosion control in 1999. Initial attempts in sweetcorn crops used direct drilling but were often subject to low or erratic emergence – especially of super-sweet varieties. Strip tillage was introduced because it offered the advantages of a cultivated seed bed while retaining full cover over much of the soil surface.

Between 2000 – 2006 LandWISE carried out on farm research across the North Island. Comparing strip tillage to conventional tillage, the aim was to determine if there were economic and environmental benefits. The practice was extended to heavier soils when farmers noted the potential to reduce costs and preserve soil condition.

A total of 43 trial sites were set up on 22 farms. In each case a cropped paddock was split in half. One half of each paddock was strip-tilled while the other was cultivated conventionally. Both halves were planted on the same day with the same varieties. The crops were managed by the farmers according to their normal practice.



Paddock split in half for a strip-till trial

Crop monitoring, including emergence, crop development and yield assessment was carried out by LandWISE. Soil quality measurements were also made, to assess changes over time. After harvest, costs, returns and gross margins were calculated.

Overall there was no difference in yields between the two systems. Gross margins were higher when strip-till produced comparable yields. However, if the strip-till was poorly managed, yield and gross margin could be significantly lower.

Advantages of Strip-Till

Wind Erosion Prevention

Wind erosion is a particular problem on light and unstructured soils. It causes absolute soil and nutrient loss. Sand blasting damages crops and young crops can have to be replanted. This both increases expenses and reduces returns as potential yield will be reduced and supply contracts not met.



Wind erosion event in Central Hawke's Bay

Soil Quality

Intensive tillage reduces soil physical quality. Cultivating only 1/3 of the field should slow or stop the decrease in soil quality.



Strip-till squash with 30% soil cultivated

Soils of higher quality require fewer inputs to grow equivalent yields. Uncultivated ground has a greater load carrying ability. This can be especially important under moist conditions when crops have to be harvested to a factory schedule.



Wind erosion can cause crop losses

Time and Cost Savings

In LandWISE trials strip-till gave considerable savings. On average cultivation cost and time was approximately halved using strip-till. This saving increases with soil quality as less passes are required.

Fewer staff can prepare a greater area of land with less machinery. This can be significant when trying to meet optimum planting dates and as labour becomes harder to find.

Fuel savings can be very large: one grower reports cultivation and planting a 30 ha corn crop reduced from 800 L/ha to 120 L/ha when he shifted from conventional practices to strip-till. Others have found fuel use drops further over time as soil quality improves.

Disease control

There was anecdotal evidence of reduced disease in some tomato trial paddocks. In two cases, very significant reduction in *Sclerotinia* was noted under strip-till. This may have been the result of less soil disturbance reducing the infection pressure from soil borne sclerotes.

In some squash fields, fruit lying on retained crop residues had less disease, as did strip-till crops where canopies were less dense.

Types of Strip-Till

There are numerous strip-till machine options available. They can be separated into tine implements and powered implements. Each has advantages and each has a place.

Regardless, it is essential that soil conditions are suitable if the equipment is to create the seedbed required and maintain soil health.

Tine Machines

There are several different designs of tine strip-till machine operating in New Zealand. These strip-till machines rely on the tine to burst soil along natural fracture lines.



DMI strip-till machine in heavy maize residue - able to cultivate twelve ~200mm strips per pass

Tine strip-till machines rely on high ground speeds to get the forces required to shatter the soil. As a guide, speed should be in the vicinity of 15 km/h – fast for most cultivating equipment. Most machines work the soil to about 200 mm leaving a v-shaped zone of tilled soil in the strip.

Soil moisture should be moderate – the same as would be ideal for other ground working. Poor results will be obtained if the soil is too wet. If soil is at the “plastic limit” it deforms like plasticine, and the knife makes a smeared slice with a mole drain at the base. It will not create tilth.

If the soil is too dry it is also unlikely that good tilth will be created. The soil will be excessively hard and unable to burst along the smaller fracture lines.

The ‘mole-knife’ machine has a 200mm tine with a small wing (‘mole’) at the tip. This greatly increases the amount of soil shattering giving

better tilth and an optimum environment for young seedlings. Not all machines have a wing.



Close-up of a mole-knife wing-tip to increase soil working

The photo below shows an Orthman tine machine.



Orthman strip-till machine cultivates strips ~ 200 mm wide

A spring-loaded residue cutting disc is followed by residue clearing discs then the main tine. The tine is in turn followed by discs which stop catch soil and rework it. The final stage is a cage roller which further works the surface tilth and consolidates the strip.

Some systems put residue managers (clearing system) ahead of the cutting disc coulter.



Parallelogram mounted knife with depth skids. Residue managers fitted at front avoid trash build-up

The residue cutting disc should be set as shallow as possible. While good cutting is required to avoid build-up of residues on the mole-knife, excessive depth pre-cuts the soil. This removes the solid bulk of soil which is needed to work against the mole-knife. It is the force of the tine against the soil that shatters soil and creates tilth.

Any springs must have sufficient loading to prevent any movement of the tine under normal conditions. The working angle is critical to performance and minor changes greatly reduce the amount of soil lift and shattering obtained.

The catching discs catch the soil thrown up by the knife, rework it, and lay it in a narrow strip. The roller at the back provides additional crumbling and consolidates the soil.



A mole-knife strip-till machine in action, note the additional soil working by the cage roller

The gathering discs shown are scalloped. In some situations, the discs throw soil on to the inter-row. This may be reduced by reversing the discs so the concave side faces away from the knife. Some machines use a roller to press and crumble the soil. Others use a cage to rework the soil and some lay it in a raised berm.



Cambridge rolling helps break any clods for better herbicide application

A Cambridge type roller towed behind the strip-till machine will also help in cloddy conditions. Some farmers have used chain harrows to crumble any clods and leave the entire field ready for a pre-emergent herbicide treatment.

Other mole-knife machine designs rely on the same principles. Some have the knife mounted on a parallelogram to ensure even engagement depth regardless of field topography. They require a depth control mechanism, generally a skid mounted slightly ahead of the knife.

Always remember to allow sufficient fallow when coming out of pasture or similar conditions. The roots must be allowed to break down and lose strength, or they will reinforce soil and prevent bursting and tilth creation.

One machine works at depths around 0.5m. It is similar in design to an aerator, with gathering discs and crumblers to help develop the tilled strip. This machine also has the ability to place fertiliser in the tilled strip.



Deep strip-till machine capable of working to a depth of 0.5m – note fertiliser coulter behind working disk

Secondary Cultivation

Secondary cultivation machines designed to follow mole knife equipment have been trialled in the US. Some of these use gangs of fluted discs to establish finer tilth.



Powered Machines: e.g. Rotary hoe



Sandy field strip tilled with a modified rotary hoe

Powered strip-till machines are usually modified rotary hoes or similar. Sections of blades are removed so that only strips are cultivated. Shields are installed to keep soil in the tilled zone.



Modified rotary hoe strip-till machine cultivating three 500mm strips per pass

This rotary hoe uses a large tine with a wing to burst the soil along natural fracture lines. The wide wings increase the width of soil shattering and amount of soil lift achieved. The ripper has no break-out so care is needed to avoid damage.



Modified rotary hoe strip-till machine with ripper leg

If a large tine is not part of the machine, a field should be ripped before strip-tilling compacted soil. The ripping will lift and shatter the soil, helping to prevent cultivation pans from forming and improve root penetration.

The rotary hoe itself is used as a secondary cultivation tool. A tyre roller at the back consolidates the soil.



Triple tyre roller consolidating the rotary hoed strip

Squash growers considered cultivating the between row area just before shoots run. A second machine would be used for this task.

The concept is for between row cultivation to provide loose soil for roots to explore, potentially leading to higher productivity. Because a substantial crop canopy already exists in the rows, the risk of wind erosion and crop damage is minimal. Others have shown this is not necessary if there is no legacy compaction.

The rotary hoe machine will handle growing pasture, but it is still important to leave time for breakdown before planting.

Sometimes a second pass is needed to get the tilth desired. An adequate seedbed is needed, but over working should always be avoided.

Powered machines such as this have also been made in Oregon to suit sweetcorn and maize row spacing – 760mm centres.

Such a machine could meet the needs of farmers wanting to plant maize or corn into a grass paddock without waiting the six weeks for roots to break down after spraying. This will not reduce pest pressure – insects and slugs will move from the dying grass into the germinating crop. Energy use is higher than tine machines.

Managing Strip-Till for Success

Strip-till is a different system of cropping, not just a change in cultivation technique. It poses different issues to conventional farming.

It is important to consider the condition of any paddock or field that you intend to crop using a reduced tillage system. Reduced tillage offers less opportunity to fix up problems such as soil compaction or poor tilth, or to level a field out.

When choosing a paddock to trial reduced tillage, start with a better performing paddock wherever possible. Choosing a paddock that hasn't performed well in the past sets you up for failure. As your experience grows, you will be better prepared to tackle the more difficult areas.

Always dig a hole to the bottom of the tilled zone and check machine performance. Make sure smearing or mole draining isn't occurring. If there are areas within a paddock that are known to be too wet or too dry it may be best to eliminate them from your cropping schedule.

Compaction

The main issue limiting strip-till success is compaction in the uncultivated areas. These areas may have been compacted by machinery harvesting the previous crop and/or from stock grazing over the winter. Compaction restricts root growth and reduces yields.

Winter grass should be established using no-till or min-till to retain as much soil strength as possible. Manage winter grazing of cropping soils carefully to avoid pugging damage. Keep stock off during wet conditions to minimise soil damage.



Platy soil structure and horizontal roots, both are sure signs of compaction

If compaction damage is evident, remedial measures such as sub-soiling or aeration are necessary.

Autumn is often the best time for aerating. The deeper soil is drier and shatters well. Do not try to aerate wet soils.

One farmer has been aerating after planting. His aim is to remove compaction after all field operations are complete, leaving the soil in good condition for root growth. It also leaves time for the soil to reconsolidate before harvest.



An aerator can be used after planting to remove compaction in inter-row areas

If severe compaction is present, consider continuing a conventional system until rotation and seasons result in a compaction free soil.

Stop compaction by

- Keeping heavy machines (especially trucks) off the paddocks whenever possible
- Using traffic lanes for machinery movements
- Matching wheel tracks when possible (Controlled Traffic System)
- No-till sowing winter grass to maintain as much soil strength as possible
- Keeping stock off wet ground

Assessing Soil Compaction

The simplest and most informative way of gauging soil compaction is digging a hole. Compare it with soil from under the fence line.

In the process you will identify how hard the ground is, if there are any hard pans, grey areas of soil indicating compaction, how dense the soil is (does it have lots of gaps or is it one big lump?).

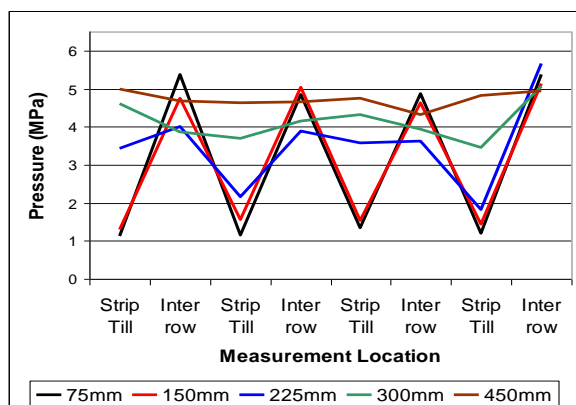
A penetrometer will show the relative degree of compaction across a paddock on a given day. As

a guide, most roots will not penetrate soil if resistance is above 3 MPa.

Penetrometers measure resistance to a probe being pushed through the soil and show depths and degree of compacted layers. Note that measurements are specific to soil moisture levels.



Hand-held soil penetrometer measures penetration resistance to give a guide to the degree of soil compaction



Penetration resistance measurements across strip-tilled rows and inter-rows



A welding rod makes a simple penetrometer: if you can't reasonably push it into soil with the palm of your hand, roots can't penetrate either

Soil Moisture

Soil moisture must be correct for good tilth to be produced. Rotary hoe machines will destroy soil structure if used in wet conditions. Mole knife machines will merely cut a slot and achieve no bursting.

Wet soil will result in mole drains instead of seed bed development. If the soil is too dry it is also unlikely that good tilth will be created. The soil will be excessively hard and will not burst along the smaller fracture lines.



Mole-knife strip-tilling in wet conditions produces a mole drain effect instead of a seed bed

Tilling at the optimum soil moisture level will give maximum soil fracturing and shattering, creating an optimum seed bed. The "worm test" is an easy means of assessing if soil conditions are right for cultivation. Remember to test the soil at the operating depth of the tillage equipment.

In certain conditions, surface soil is drier and working to a shallow depth may be possible.

WORM TEST

Take a small amount of soil and roll it between your palms.

If you can roll a 'worm' less than 4mm in diameter, the soil is too wet to cultivate safely. If you can roll a worm less than 3mm, the ground is too wet to even drive on.

If the soil crumbles before it gets to 4mm thin, it is suitable for cultivation. If you cannot roll it at all, it is probably too dry.

Fallow Period

The standard recommendation is to ensure at least 4-6 weeks spray fallow when using strip-till systems. This enables better tith creation and reduces pest incidence.

Fallow is particularly important when growing corn or maize in fields out of pasture. A longer fallow reduces pest pressure by starving the pests before planting. Seed treatment will also help in reducing pest damage.



Fresh grass roots act like reinforcing mesh, preventing shattering and seed bed development

A tine strip-till machine usually requires 4-6 weeks fallow after spraying out pasture for grass roots to break down. Otherwise the roots will prevent the soil from shattering into small aggregates. This results in poor seed to soil contact and reduced germination.

It is possible to spray out the strips to be tilled but continue grazing the rest of a pasture. Using a parallelogram arm system ensures the spray nozzle is at correct height regardless of contours. The whole paddock can be sprayed out after strip-tilling and planting, but before emergence.



Strip sprayed pasture allows for root breakdown yet pasture and be grazed for a further 6 weeks

Residue Management



Residue managers clear cultivated strips and lay mulch in the inter-row

Strip tillage and other reduced cultivation systems generally retain more crop residues. There are three steps that prevent residue from becoming a problem

- Mulch the residue so that it flows easily through machinery
- Install residue managers on the strip-till machine so an even, clean seed bed is developed
- Ensure pre-emergent herbicides are applied at the optimum time

Weed Control

Effective weed control is essential. In a strip-till system, conventional inter-row cultivation may be impractical. With a good clean start the weeds should remain manageable.



A clean start often follows through the life of the crop

Stale seed beds and wise residual herbicide use appear to provide good weed control, and it has been noted that the undisturbed inter-row generally produces less weeds.

Problems have resulted from lumps of soil spilling from the cultivated strips on to the inter-row. The lumps shield the soil surface from herbicides, allowing weeds to establish. Avoiding soil spills, or rolling or harrowing the field to shatter lumps, addresses this problem.

Hooded sprayers that spray between rows are available and suitable if residual herbicides were not used or were not effective.

Pest Management

A 4 to 6-week fallow reduces pest pressure by starving pests such as Stem Weevil. Seed treatment will also help in reducing pest damage.

Slugs are of concern, especially with early plantings in high residue environments and in cool, moist conditions. Reduce pressure by limiting the places for them to shelter:

- Allowing sprayed pasture to die down
- Sweeping residues well clear of the emerging seedlings
- Producing a quality consolidated seed bed so slugs can't crawl under clods to get to the seedlings
- Ensuring no open slots are left for slugs to crawl along and chew on germinating seedlings

Monitor for slugs and use slug bait if necessary.



Seedlings in open slots are at risk of slug damage and poor emergence

Residue swept clear of row with good slot closure makes a less favourable environment for slugs

Strip-Till Summary

LandWISE trials have shown strip tillage to be a viable option for cropping farmers. It effectively prevents wind erosion and reduces adverse effects of cultivation.

Strip tillage offers considerable time and fuel savings. Yields can be equivalent to those achieved with conventional cultivation. Together these offer increased crop gross margins.

If strip-tillage is not done appropriately yield can be significantly reduced. The most common problem is failing to manage a legacy of compaction. This reduces root growth and must be avoided.

A whole farm approach is needed, with winter land management practices impacting significantly on subsequent summer crops.

There are two main types of strip-till machinery, powered or tined implements. Tined implements require careful management but offer considerable advantage if applied correctly.

Useful web sites

- www.landwise.org.nz
- www.striptillfarmer.com
- www.orthman.com
- www.yetterco.com
- www.slyagri.com/stripcat-2/

See Hugh Ritchie explaining strip-till on the LandWISE video by precisionagriculture.com.au at

https://www.youtube.com/watch?v=nWt_4neXUwQ





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