SoilWealth
NURTURING CROPS

Reducing tillage in vegetable crops

Is it worthwhile?

Reduced tillage can produce similar or better yields than more aggressive conventional tillage. By overcoming the practical challenges of reduced tillage, the door to improving soil health is opened.

This fact sheet outlines the pros and cons of reducing the intensity of cultivation in vegetable production systems. It is based on lessons learnt from three demonstration sites conducted as part of the 'Soil Wealth' and 'Integrated Crop Protection' (ICP) projects (2014 – 2016).

"We found that you can halve the number of passes and still grow great crops."

Note that the information and data presented from the three sites is based on demonstrations and not replicated research trials. You need to consider how the information applies to your own situation.

Key benefits and challenges of reduced tillage in vegetable crops

The key benefits of reducing tillage are:

- **Improving soil health**
- **Earlier access to paddocks and therefore better timing of operations after rain/irrigation**
- **Lower fuel costs due to fewer passes**
- **Lower labour requirements, reducing hired labour costs or freeing-up operator time for other crop management**
- **Reducing the amount and size of tillage equipment needed, resulting in lower machinery investment**
- **Reducing soil loss from water and wind erosion**
- **Conserving soil moisture and improving long-term soil health.**

We found the following key challenges, which were more pronounced under no till practices:

- **Pest populations need to be monitored more closely because reduced tillage means that crop residues can potentially harbour insects and slugs**
- **Weed management is more complicated because tillage operations are not used to control weeds. There may be a need to increase the number of pre-plant herbicide applications and/or increase the application rate for post-emergence herbicides**
- **Crop establishment (transplants and seed) may require machinery modifications as the seed bed is not as fine**
- **Trash management.**

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Bathurst site

What did we do?

Michael Camenzuli worked with the Soil Wealth team to look at no till permanent beds and cover crops within the rotation of cabbage and pumpkins.

The practices were:

1. No till permanent beds + cover crops (2 initial cultivations)
2. Conventional till + cover crops (rip, disc x 2, rotary hoe/bed former)
3. Conventional till (rip, disc, rotary hoe/bed former)

The timelines for the above treatments are detailed below.

Table 1: Timeline of operations for Bathurst site.

		NO TILL PERMANENT BEDS + COVER CROPS	CONVENTIONAL TILL + COVER CROPS	CONVENTIONAL TILL
2014	Apr	Tillage (2)	Tillage (2)	Tillage (2)
	May	Oats + Vetch	Oats + Vetch	
	Jun			
	Jul			
	Aug			
	Sep			
	Oct			
	Nov	Tillage (0)	Tillage (4)	Tillage (3)
	Dec	Pumpkin	Pumpkin	Pumpkin
2015	Jan			
	Feb			
	Mar			
	Apr			
	May	Tillage (0)	Tillage (3)	Tillage (3)
	Jun	Oats + Vetch	Oats + Vetch	
	Jul			
	Aug			
	Sep			
	Oct			
	Nov	Tillage (0)	Tillage (4)	Tillage (3)
	Dec	Cabbage	Cabbage	Cabbage
2016	Jan			
	Feb			
	Mar			
Total tillage		2	13	11

What did we learn?

We need to manage the increased risk of pest damage especially when cover crops are combined with no till

Early establishment of pumpkins was a problem in the no till permanent beds. Symphilids were particularly active that spring, attacking the pumpkin seedlings and replanting was required (Figure 1). The cover crop may not have been terminated early enough and provided a “green bridge” through to the crop. Cultivation is an effective control measure for symphilids and hence damage was low in the tilled beds.

Symphilids were also a problem in broadacre crops that year suggesting that seasonal conditions may have increased the problem. Further seasonal observations would be required to see if symphilids were a ‘one off’ or are an ongoing issue under reduced tillage.

Figure 1: Symphilids appeared in high numbers, especially on the no till permanent beds with cover crop. Pumpkin seedlings were attacked and had to be re-planted.

Increased pumpkin yield in no till beds

Pumpkins in the no till beds were larger and therefore yield was greater than the tilled beds.

Table 2: Yield of pumpkins grown under three soil management practices (2014-2015). No till practice had not been cultivated since early 2014, conventional tillage (with cover crop) had been cultivated 10 times and the conventional tillage (no cover crop) cultivated 8 times.

	NO TILL PERMANENT BEDS + COVER CROPS	CONVENTIONAL TILL + COVER CROPS	CONVENTIONAL TILL
Number of pumpkins per plant	2.2	2.6	2.2
Average weight (kg)	7.9	5.0	6.8
Yield (t/ha)	**46**	**35**	**40**

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Gippsland site

What did we do?

Bulmer Farms together with the Soil Wealth team trialled a range of soil cultivation practices that reduce the amount of tillage and enhance the soil health benefits with cover crop or compost. Table 3 shows the three treatments and timeline of main operations. Over a period of 20 months, the low till plot was tilled 7 times, the reduced till, 15 times and conventional till, 25 times.

Table 3: Timeline of operations for Gippsland site.

		NO TILL + BIOFUMIGANT	REDUCED TILL + COMPOST	CONVENTIONAL TILL
2014	Jun	Tillage (4)	Tillage (4) Compost	Tillage (4)
	Jul	Caliente Biofumigant	Spinach crop 1 Tillage (2)	Spinach crop 1 Tillage (2)
	Aug			
	Sep		Spinach crop 2	Spinach crop 2
	Oct			
	Nov	Tillage (0)	Tillage (1)	Tillage (5)
	Dec	Lettuce	Lettuce	Lettuce
2015	Jan			
	Feb	Tillage (0)	Tillage (2)	Tillage (5)
	Mar	Baby brocolli	Baby brocolli	Baby brocolli
	Apr			
	May			
	Jun			
	Jul			
	Aug			
	Sep	Tillage (1)	Tillage (2)	Tillage (5)
	Oct	COVER CROP Sorghum + tillage radish	COVER CROP Sorghum + tillage radish	COVER CROP Sorghum + tillage radish
	Nov			
	Dec			
2016	Jan	Tillage (2)	Tillage (2)	Tillage (5)
	Feb	Baby leaf spinach	Baby leaf spinach	Baby leaf spinach
	Mar			
	Apr	Tillage (0)	Tillage (2)	Tillage (5)
	May	Lettuce	Lettuce	Lettuce
	Jun			
	Jul			
	Aug			
Total tillage		7	15	31

The practices were:

1. No till (4 initial cultivations and strategic tillage)
2. Reduced till (disc and rotary hoe/bed former)
3. Conventional till (rip x 2, disc x 2, rotary hoe/bed former).

What did we learn?

Transplanting equipment may need to be modified or adapted

Transplanting of iceberg lettuce seedlings (2014) was hampered by trash remaining in the low till and reduced till treatments. Key lessons learnt included:

- The need to fit discs that could cut through plant trash
- Allowing sufficient time to experiment with the level of the transplanter, appropriate speed when transplanting, and positioning of discs.

Some seedlings in the cover-cropped practice were also planted too deep, which led to coning of plants and a loss of yield. It is likely that this would have been caused by running the planter slowly.

Trash can cause leaf perforations in wind

Around 3–4 weeks after transplanting, holes started appearing in the leaves of the crop in the cover cropped area (low till and reduced till practices). Some of these had been caused by slugs, others were perforations in the leaf caused by wind and the trash that remained in these beds. Whilst slugs can easily be baited for, leaf perforations caused by trash may only be avoided by mulching remaining material on the bed prior to transplant, which may not be practical.

The best lettuce yield was achieved in the 'no till + biofumigant' treatment

Lettuce yield (2014/15) was assessed on the same date for all treatments. Lettuces in the 'low till + biofumigant' treatment were heavier and firmer than those grown using conventional tillage. The difference in yield may be at least partly due to different stages of maturity between the treatments.

Table 4: Average head size and crop yield of iceberg lettuce grown under three soil management practices (2014/15).

	NO TILL + BIOFUMIGANT	REDUCED TILL + COMPOST	CONVENTIONAL TILL
Average head weight (g)	685	590	545

Reducing tillage in vegetable crops - Is it worthwhile?

Gippsland (continued)

Baby broccoli crop highlighted the need to modify or adapt transplanting equipment

A baby broccoli crop was planted in February 2015 and grown through to September 2015. There were lodging issues in the plants transplanted into the low till area because of issues at transplant. Press wheels (or similar) at transplant may have prevented this from happening by ensuring the seedling was firmly in place. When harvesting commenced in early May these plants had recovered.

Due to the continuous harvest of baby broccoli side shoots over months it was not possible to collect yield data under commercial conditions.

The best spinach yield (2016) was in the reduced and low till plots

A baby leaf spinach crop was grown from February to April 2016. Prior to this a summer cover crop had been grown across the site. The mulched cover crop was incorporated into the soil with decreasing amounts of tillage; conventional tillage area was disced twice, ripped and rotary hoed and bed formed, reduced till area ripped and rotary hoed and bed formed, low till area was rotary hoed and bed formed. Final spinach yields are shown in Figure 2.

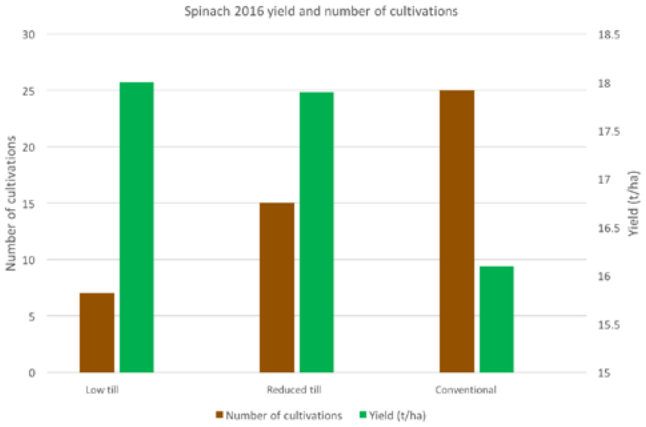

Figure 2: Yield of 2016 baby leaf spinach grown following the establishment of three soil management practices. Over the previous 20 months four previous crops had been grown and the conventional, reduced till and low till practices were cultivated 25, 15 and 7 times. Values are the fresh weight at harvest.

Figure 3. Improved soil structure and stability pays off in extreme weather. With more than 100 mm falling in one day the benefits of reduced tillage were clear. The no till beds (left) held up well and the area could be accessed by traffic much earlier than the conventional tillage area (right) with less crop and soil damage.

Werribee site

What did we do?

Fragapane Farms together with the Soil Wealth team looked at three soil practices:

1. Conventional till (6 cultivations per crop)
2. Reduced till (2 cultivations i.e. deep rip and power harrow)
3. No till in first crop and then changed to Minimum till + compost (power harrow + compost application).

What did we learn?

Reduced tillage improves soil structure

The conventional tillage area was cultivated 23 times for three crops, compared to just six times in the reduced tillage area. The visual results are quite striking (Figure 4). The grower remarked that “the reduced till is a winner, there is more healthy looking roots and it felt softer than the conventional till which was surprising. The rip and power harrow gives the plants what they need”.

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Figure 4. At the end of the third lettuce crop the soil in the reduced till area is supporting healthier roots and the soil structure is starting to be rebuilt. Werribee demonstration site.

In 'backing off' on tillage we are giving the biology in the soil the chance to develop a more stable soil structure. We can see this starting to happen in the reduced tillage area where two months after planting the reduced till soil is in better shape than the conventional tilled soil (Figure 4).

While aggressive tillage creates a soft bed at planting, this doesn't last. After the first rain or irrigation slumping happens and the soil can end up worse off than before cultivation.

Planting equipment needed a different set up when using no till

The no till bay was a challenge, as the soil was very hard, the bracket bolt connecting the coulter attached to the transplanter, sheared. We finished the planting using a tyne at the front of the planter to break the soil surface.

Reduced tillage performed better than no tillage

In the first baby cos crop, the crop in the no till treatment failed. This area was then changed to a minimum till + compost treatment prior to the second baby cos crop. Yield data is shown in Figure 5 (below) for two baby cos crops as a % of the conventional tillage treatment.

Yields in the reduced till beds were similar to conventional. Therefore, assuming tillage costs saved of $95/ha, reduced tillage is an economic option.

In the second baby cos crop, the minimum till + compost treatment yielded similar to the conventional but the added cost of compost means that this was not economic in the short term. Compost can cost between $150/ha and $220/ha depending on compost type, compost quality, transport costs and application machinery used and costs. This type of system may be economic over the longer term and nutrients from compost need to be taken into consideration.

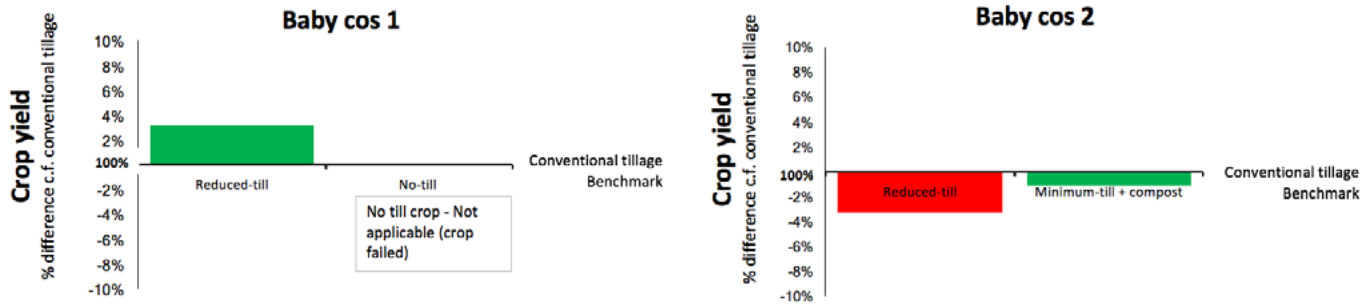

Figure 5: Yield relative to conventional tillage plot for two baby cos crops.

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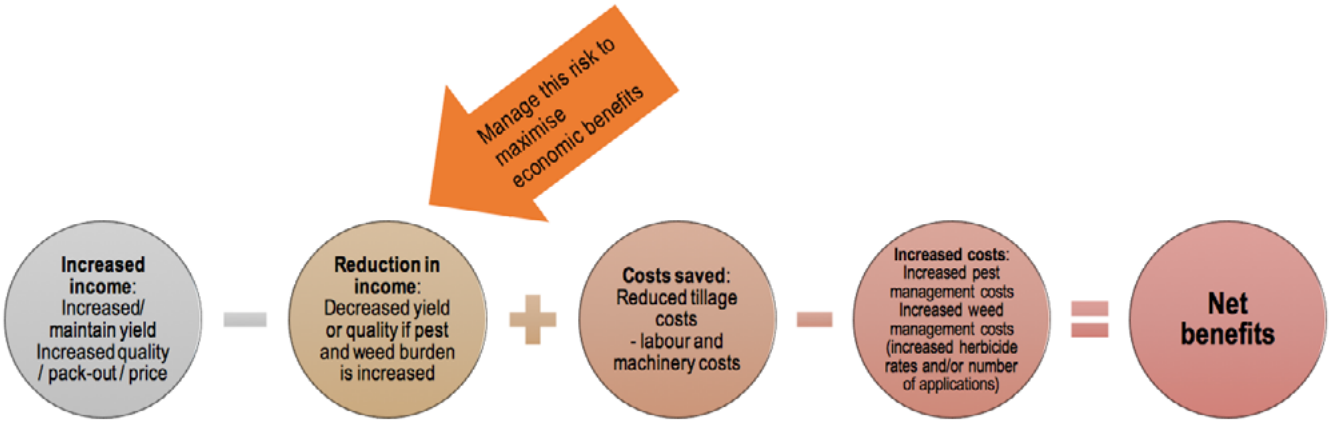
The bottom line

Main potential economic benefits and costs of reduced tillage



Consider the longer term economic benefits

Improved soil structure and improved soil health provides longer term benefits e.g. reducing the risks of soilborne disease and also reducing costs associated with extreme weather events such as floods.

Although longer term benefits have not been fully captured in the data shown above, longer term benefits should be considered when deciding about management practices including tillage systems.

The aim is that the increased income and/or reduced tillage costs will more than cover any additional costs for pest and weed management.

Table 6: Reduced tillage costs

TILLAGE SYSTEM	TOTAL NUMBER OF TRACTOR PASSESS	HOURS*	COST/HA**
Conventional	12	3.14	$223
Reduced till	7	1.83	$130
Permanent beds	3	0.79	$56

* assumption that conventional land preparation requires 3.14 hours per hectare
- http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/470026/Lettuce-gross-margin-budget.pdf

** assumption that cost of land preparation is $71 per hour ($46 per hour variable cost associated with tractor use (225hp John Deere 8225R) and $25 per hour of labour)
- http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/175494/135-kw-to-166-kw-tractor.pdf

Further resources:

- **Managing cover crop residues in vegetable production**
  http://www.soilwealth.com.au/imagesDB/news/ManagingCoverCropResiduesSWICP.pdf
- **Reduced till in vegetable production – WHY?**
  http://www.soilwealth.com.au/resources/videos/reduced-till-in-vegetable-production-why/
- **Reduced till in vegetable production – HOW?**
  http://www.soilwealth.com.au/resources/videos/reduced-till-in-vegetable-production-how/
- **Reduced till in vegetable production**
  http://www.soilwealth.com.au/imagesDB/news/RedtillSW12150203.pdf