

Soil management for commercial vegetables & small crops

Simon Eldridge, Soil Scientist, NSW Agriculture, Richmond

This publication aims to help North Coast commercial vegetable growers maintain sustainable production by protecting their soil from the problems of erosion, compaction, acidity and nutrient decline.

PREVENTING SOIL EROSION

- **Avoid steep slopes.** The steeper the slope, the greater the risk of soil erosion. Slopes less than 10% (6°) are preferred for vegetable production because of their lower soil erosion risk. For steeper areas, the following erosion control measures become even more essential.
- **Graded banks or cross-drains** built across hillslopes reduce the capability of stormwater run-off to erode bare, exposed soil. The banks achieve this by reducing the speed and volume that run-off flows can generate over the paddock. The collected stormwater run-off is carried by banks and safely discharged into a stable, well-grassed waterway. Bank systems can be designed for compatibility with different vegetable crops and associated machinery operations.
- **Waterways** carry collected stormwater run-off away from the site to the nearest natural stream. Keep your waterways well grassed to avoid soil erosion.
- **Diversion banks** can be placed above a cropping area to divert potential run-off.
- **Sediment traps** should be considered for the lowest corner of paddocks to minimise soil loss during extreme rainfall events.

Consult the soil services section of the Department of Lands for advice on the design of sediment traps.

Note: Professional advice on the design and layout of graded banks and waterways should be sought from the soil services section of the Department of Lands, early in the planning stage.



The effects of soil erosion on a bare, unprotected field.



A rotary drain digger making temporary erosion control banks in a potato crop.



Graded banks controlling soil erosion at Cudgen.



Maintain good grass cover on waterways and drainage lines.



Driving vehicles in waterways can result in severe soil erosion.

- **Keep drainage lines well-grassed.** Natural drainage lines should be maintained in a natural, grassed condition for the safe disposal of stormwater run-off.

Avoid cultivation or the driving of vehicles in these areas as this can result in severe soil erosion.

Regularly slash the grass in waterways to prevent it from disrupting water flows.

- **Work paddocks across the slope.** Follow this practice, wherever possible, to minimise soil erosion. Where this is not possible, a well-designed soil erosion control system may be necessary.
- **Grow cover crops.** Cover crops are grown mainly to protect soil from erosion. They also add valuable amounts of organic matter to soil. They can be either permanently established, such as between long-term vegetable beds, or temporarily

established between successive vegetable crops. They are usually slashed or sprayed-off before the next vegetable crop.

SOIL STRUCTURE AND PREVENTING SOIL COMPACTION

Reduce the number of soil workings

Soil structure refers to the way soil particles are arranged into individual aggregates (lumps) and to the spaces and holes within and between these aggregates. Well-structured soils have lots of pores (holes) and spaces in the soil to allow good drainage and aeration and easy plant root growth. Organic matter is essential for good soil structure as it helps bind the soil particles together. To maintain good soil structure, you should adopt practices which maintain the levels of organic matter in the soil and minimise cultivation which pulverises the soil and destroys its structure.

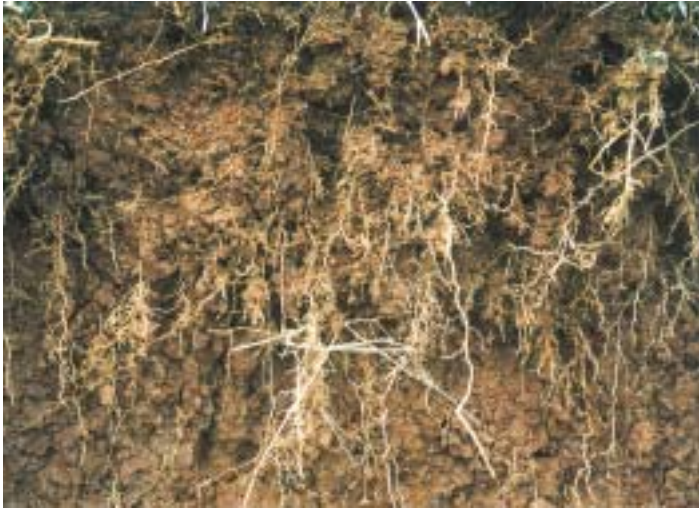
Excessive cultivation can damage your soil's structure and result in soil compaction, surface crusting problems, reduced soil moisture storage, and lower yields. Cultivation can be minimised by adopting the following practices.

Weed control

- Control weeds with herbicides rather than cultivation. The use of herbicides is usually cheaper than cultivation; and soil structure is not damaged.
- **Plastic or organic mulches** can also be used to control weeds as an alternative to herbicides. The use of plastic mulch coverings in combination with raised beds and trickle irrigation has proven popular in the tomato industry.



Oats as a winter cover crop between tomato beds. Note the use of plastic mulch and herbicide to control weeds.



Well-structured soils grow the best crops.



Surface crusting, caused by excessive cultivation, reduces seedling emergence.



Tyned implements are easier on the soil.



One pass with this 'Power Harrow' over sprayed-off pastures can produce a suitable seedbed for potatoes¹.

Seed bed preparation and sowing

- **Minimise the use of rotary hoes.** These destroy soil structure by pulverising the natural soil aggregates into tiny particles and by compacting the soil below the seed bed.
- **Use tyned and non-inverting implements.** These are preferable to discs and mouldboard ploughs. Tyned implements open the soil up without pulverising it.
- **Use any innovative or modified machinery** which helps to minimise the amount of soil disturbance involved in ground preparations for the crop.

Machines that hill and plant in the one operation help reduce the number of soil workings.

- **Ground preparation for vegetables sown as fine seed.** In many cases, this only needs to consist of one or two passes with a chisel plough or scarifier-type implement prior to sowing.



Machines that hill and plant in the one operation help reduce the number of soil workings.

¹ The development and adaption of a minimum tillage approach by the Robertson potato growers using the Power Harrow has resulted in increased potato yields and reduced soil erosion for the growers of that area.



A deep ripper for shattering a 'hardpan' layer.

Tillage should aim to produce a range of soil aggregates in the 0.5–20 mm size range to provide good seed soil contact without destroying the pores or holes in the soil that are needed for good drainage and aeration¹. An additional pass with a rotary hoe may sometimes be necessary when there is too much trash on the surface.

- **Ground preparation for vegetables sown as seedlings.** In many cases, this only needs to consist of a single pass with a chisel plough/scarifier-type implement followed by bed forming, where necessary, prior to planting.
- **Adopt the 'permanent raised bed' cropping approach wherever possible.** This involves trying to get as many crops out of your rows or beds as possible before reworking your paddock. This not only saves money and time, but also helps maintain the soil in a good condition. Suitable for many situations where vegetable crops are grown on formed beds.
- Keep farm machinery and vehicle wheel tracks to **designated laneways** to minimise soil compaction.
- If dense compacted soil layers or 'hardpans' are present in the soil at cultivation depth, they should be shattered by **deep ripping** the paddock with a suitable tyred implement. This needs to be done prior to preparing the ground for the next crop.
- **Try to only cultivate the soil when moisture content is right!**

¹ Adem H and Aumann C 1997, *Sustainable Soil Systems for Horticulture*, DNRE Vic, Horticulture Down Under Conference, Barooga, 25–26 Nov.

Cultivating the soil when it is too wet or dry will damage the soil structure and produce a compacted soil layer. Heavy clay soils are best cultivated when the soil is dry. If a handful of clay soil can be rolled between your hands into a rod which is less than 3 mm in diameter without it crumbling, then the soil is too wet to plough. Light sandy, silty, or loam soils should only be cultivated when there is enough moisture in the soil for a handful of it to be squeezed into a coherent ball, but not enough moisture for the soil to feel wet.

Ask your NSW Department of Primary Industries Soils Advisory Officer for an information sheet on assessing soil moisture for cultivation.

- **Does your soil need gypsum?** Gypsum is sometimes promoted as a 'cure-all' for soil surface crusting and drainage problems. Gypsum, however, is only likely to improve your soils structure and drainage if laboratory tests show that your soil is dispersible or sodic (that is, high in sodium with an ESP > 6).

Obtain the *Does your soil disperse?* leaflet from your Soils Advisory Officer.

Increase soil organic matter:

- Adequate levels of organic matter need to be maintained in the topsoil to stabilise the soil structure. Soil organic matter helps to bind the soil particles together into aggregates and is also very important for the retention of soil moisture and nutrients. The following techniques can be used to maintain adequate levels of organic matter in the topsoil:



Permanent raised vegetable beds with a slashed cover crop.

- **Green manure crops** are crops which are grown specifically to add organic matter and nutrients to the soil by being slashed or ploughed into the soil. They help improve your soil's chemical and physical fertility — especially if the crops are legumes. Green manure crops are best ploughed in long enough before planting of the next crop to allow the organic matter to break down.



Ploughing in sorghum — a green manure crop.



Testing potassium and nitrogen levels in a tomato crop.



Liming to fix a soil acidity problem.



Soil test results can help you ensure that your crop is well-fed and productive.



A soils assessment can save you money.

Growers in the Cudgen area usually plough them 4–8 weeks before planting. Growers in the Sydney Basin area have found a two-week interval to be sufficient in most cases, especially when conditions are warm and moist. Note that incorporation of the green manure crop by over-vigorous cultivation can undo any of their benefits by damaging the soil structure — consult your local adviser on which green manure crops are most suited to your situation.

- **Cover crops** add valuable organic matter to the soil and can be ploughed into the soil after harvesting.
- **Vegetable crop plant residues (stubble)** left in the field after harvesting can be also be ploughed into the soil as a source of organic matter.
- **Five-year pasture phases** are an ideal way to increase the amount of organic matter in the soil in areas that are only temporarily devoted to vegetable production.

- **Organic fertilisers**, such as ones based on animal manures, provide another source of organic matter for the soil. The generally lower nutrient analysis and the slow release nature of these fertilisers needs to be taken into account when determining application rates and costs. Consult your local horticultural adviser on this.

MAINTAINING YOUR SOIL'S FERTILITY

Good soil fertiliser management involves ensuring that the soil nutrient needs of the vegetable crop are met by fertiliser inputs and that this is done without any associated water pollution problems.

- **Test your soil regularly.** Regular soil testing (once a year) can help ensure that the correct amount of fertiliser is applied to the soil to satisfy the nutrient requirements of the crop. A full soil test should be done by an accredited laboratory. Soil sampling should be done within eight weeks of planting to ensure that results are current. Sampling guidelines should be carefully followed. Fertiliser companies can provide recommendations on fertiliser application rates based on soil test results. Also, consult your district horticulturist on the nutrient requirements of each crop.
- **Leaf tissue tests.** Leaf analysis can complement soil analysis in determining a crop's nutrient needs. Leaf analysis gives a more reliable indicator of trace element deficiencies in the soil (that is, copper, zinc, manganese, iron, molybdenum and boron). Sampling guidelines should be carefully followed.
- **On-farm monitoring of crops and soils.** Pocket-sized plant sap-test LED meters can reliably check if nitrogen or potassium imbalances are present in tomato and potato crops. Soil pH test kits are also available. Such monitoring kits however are only an aid and are no substitute for having regular soil and plant tissue testing done by certified laboratories.
- **Soil acidity** is important because it affects the availability of nutrients to the plants. Most soil nutrients are available to plants in the soil pH range of 5–7 (CaCl₂ method). Strongly acid soils (pH less than 5) require the addition of lime or dolomite to allow better plant uptake of soil nutrients and to avoid aluminium and manganese toxicity problems.

Fine agricultural lime or horticultural lime is normally the preferred liming material. Dolomite is generally only used when soil test results show that the soil is low in magnesium as well as pH.

— Ask your adviser what the ideal soil pH level for your vegetable crop is.

- **Fertiliser applications.** Consult your advisers and fertiliser companies on the best way to apply each fertiliser to the crop. This is because each fertiliser differs in terms of how strongly it is held by the soil and in its potential to damage seedlings if applied incorrectly.
- **Fertigation.** Fertigation is the application of soluble fertilisers with water through a micro-irrigation system. This allows greater precision and less waste in the application of fertilisers — especially nitrogen fertilisers. Urea and potassium nitrate are well suited to use in these systems.
- **Cadmium levels.** Cadmium (Cd) is a heavy metal that is present in rock phosphate used in the manufacture of essential phosphorus fertilisers. Root crops (for instance, carrots and potatoes) and leafy vegetables can accumulate higher levels of cadmium from the soil. Help prevent the cadmium concentration in your vegetables exceeding the Maximum Permitted Concentration (MPC) by following the guidelines outlined in NSW Agriculture's Agfact H8.AC.2. *Managing cadmium in vegetables.*

REDUCING DISEASE PROBLEMS

Crop rotation

Regular green manure/cover cropping breaks, along with occasional alternate vegetable crops rotations, can help minimise soil-borne disease problems. Note that there are also chemicals that can be applied to treat the soil to control diseases and insect problems before planting, but these are expensive in comparison to simple preventative measures such as crop rotation.

— Consult your local horticulturist on the most effective pest and disease control measures.

HAVE YOUR SOIL ASSESSED

- Before committing land to vegetable production, it is wise to have your soils assessed to ensure that they are suited to the intended crops. The best soil types for vegetables are deep, well-drained sandy loams and loams. The red basalt soils are ideal as they are well-structured and well-drained. Poorly drained heavy clays and texture-contrast soils are less suitable. Consultants or advisers who are professionally trained in horticulture or soil science can carry out this assessment.

WHAT THE FARMERS SAY

‘I reckon the contour banks work great. We’ve lost no soil since they were put in. The little bit of ground we’ve lost to the banks, we’ve made up for by the prevention of lost crops from washouts. Before the banks went in, we could easily lose 10% of the crop to soil erosion.’

‘Every year we grow a green manure crop of sorghum after our vegetable crop, and disc it in.’

— *Mark Eglington, vegetable grower, Cudgen.*



— *Neville Beaumont, potato grower, Dorrigo.*

‘You’ve definitely got to have some sort of erosion control made up of contour banks, drains and waterways.’

‘Turning in green manure crops improves the structure of the soil.’

‘Cultivating the soil when it is too wet should be avoided as it makes the soil cloddy, which can interfere with mechanical harvesting.’

FURTHER INFORMATION

Further information is available from your local NSW Department of Primary Industries Enquiries Officer, Soils Advisory Officer or District Horticulturist.

Publications

- *SOILpak for vegetable growers*, NSW Agriculture, 2000.
- Agnote DPI 327 *Protect your land — use cover crops*.
- Agnote DPI 326 *Runoff: Money down the drain — soil and water losses from vegetable farms in the Hawkesbury district*.
- *Soil Sense — Soil Information for North Coast Farmers*, NSW Agriculture, 2000.
- 'Soil Sense' leaflets (various titles) available from NSW Department of Primary Industries.
- *Best practice guidelines for growing vegetables*, www.agric.nsw.gov.au/reader/vege-bestpract
- Agnote DPI 186 *Vegetable Help Directory: A self-help guide for growers*, 1997, NSW Agriculture.
- Numerous Agnote and Agfact leaflets on specific aspects of vegetable growing are available from NSW Department of Primary Industries offices.
- *Dorrigo Potato Lands: Potato growers handbook for erosion control*, NSCP, Department of Infrastructure, Planning and Natural Resources, 1993.
- *Erosion Control at Cudgen NSW: A model for Tweed vegetable growers*, NSCP, 1993.
- *Growing green manure crops at Cudgen*, NSW, NSCP, 1992.

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DISCLAIMERS

The information contained in this publication is based on knowledge and understanding at the time of writing (July 2004). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date, and to check currency of the information with the appropriate officer of NSW Department of Primary Industries or the user's independent adviser.

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