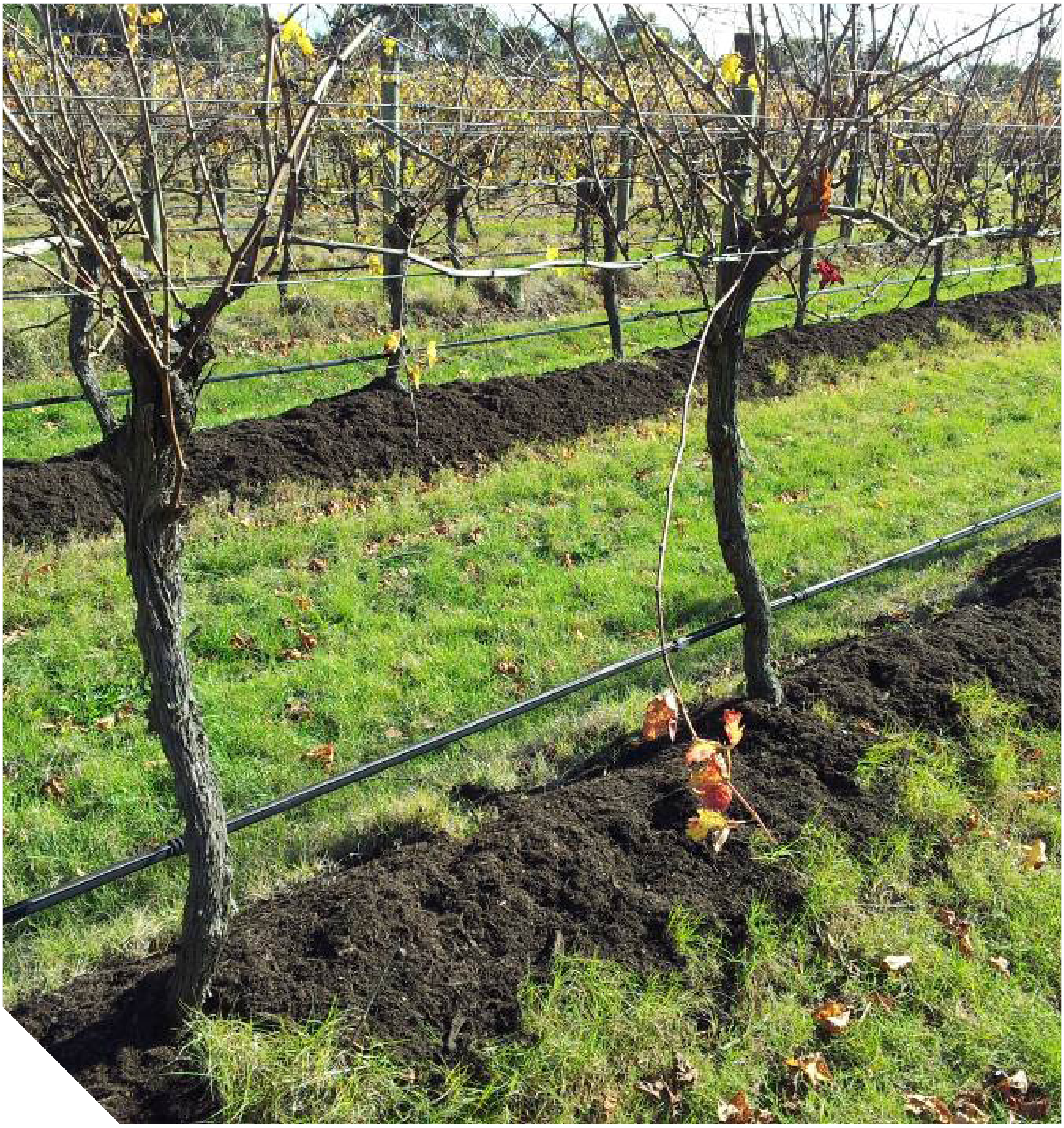
GUIDE

Conducting compost demonstration trials in agriculture/horticulture



Sustainability Victoria

State Government Victoria

Conducting Compost demonstration trials in agriculture/horticulture

March 2015

Authorised and published by
Sustainability Victoria,
Level 28, Urban Workshop
50 Lonsdale Street Melbourne
Victoria 3000 Australia

Accessibility
This document is available in PDF and Word format on the internet at www.sustainability.vic.gov.au

Conducting Compost demonstration trials in agriculture/horticulture should be attributed to Ken Orr.

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Introduction

This basic guide provides compost producers, sellers and end users with considerations when developing on-farm demonstration trials in agriculture/horticulture for compost products. It describes how to set up on-farm trials to demonstrate the benefits of using compost (organic matter) for agriculture and horticultural farming practices.

An on-farm demonstration, which is the focus of this guide, and scientific trials have long been used in agriculture/horticulture to:

- solve production issues
- aid adoption of new practices and technologies
- improve profitability and maintain sustainability of production.

One of the major functions of using trials is disseminating useful and practical information. On-farm demonstrations of products or new practices can serve as one of the most effective marketing/education tools developed for agriculture/horticulture markets. Although demonstrations require time and effort, the payback comes when producers more readily adopt practices they perceive to be appropriate under local conditions. This is known as "seeing is believing".

Demonstration trials should not be casually developed or implemented, instead, as the name implies, demonstrations should have predictable outcomes based on a research foundation. Demonstrations should illustrate the application of appropriate practices, that is, practices that fit the local set of conditions.

Overall this guide covers the following topics:

- Planning
- Designing
- Implementing
- Analysing results
- Reporting

Organic matter

Importance of organic matter

Many Australian agricultural and horticultural soils are low in organic matter (0.5-2%) and require inputs of organic matter on a regular basis. For successful plant growth the soil needs to provide the growing crop with; water, air, nutrients and physical support.

One of the components of soil that provides all of these needs is organic matter. Organic matter is an important part of the soil aggregation or structure, it helps retain and circulate moisture, air and nutrients for plant roots, stems and canopy.

Soil organic matter is naturally derived from living plants and animals and from dead and decaying plants and animal remains. Soil organic matter is decomposed by soil organisms (micro fauna and flora) into humus and other organic compounds. It interacts with the other soil components and is the major factor in establishing and maintaining the soil's biological, chemical and physical properties. Organic matter has a major impact on soil structure and biological activity.

Soil organic matter has been shown to:

- act as a stabilising agent for soil aggregates and structure
- decrease erosion losses
- improve soil water infiltration and holding capacity
- supply plant nutrients
- provide energy and nutrients for micro-organisms
- reduce phosphorus fixation and increase phosphorus availability
- moderate extreme soil temperatures
- buffer against rapid changes in salinity, alkalinity and acidity
- add to the cation exchange capacity of a soil.

Organic matter content in the soil is influenced by cultivation, depth, soil type and climatic conditions e.g. temperature and rainfall. Generally in wetter areas there is more organic matter in the soil whilst the warmer regions tend to have low levels.

Managing soil organic matter

Unacceptably high losses of organic matter can occur via a number of processes that need to be controlled including:

- excessive tillage, leading to exposure and oxidation of the organic matter
- loss of topsoil by water and wind erosion
- burning or removal of crop residues.

Cultivation can seriously deplete the soil of its valuable organic matter, particularly in sandy soils.

Organic matter in the form of recycled organic compost can be used in agriculture/horticulture for:

- pre-plant applications in intensively cropped, highly worked soils in annual vegetable production e.g. Werribee
- pre-plant applications in new intensive fruit, nut and vine plantings e.g. Sunraysia
- annual applications in existing perennial crop plantings e.g. grapevines and orchards in Goulburn Valley
- top dressing in pasture enterprises e.g. dairying
- top dressing cropping enterprises e.g. cropping on sands in the Mallee
- stabilisation and moisture retention in sandy soil with low organic matter e.g. Mallee
- amendment application in sodic soils e.g. Loddon catchment
- land rehabilitation sites – mining, salinity, landfill
- stabilising sandy or windblown sands.

Conducting a trial

Purpose

There are a number of dynamics which aid the adoption of new technologies and practices in agriculture: awareness, interest, evaluation, trialling and adoption. Government agencies, industry bodies and service providers (suppliers who service the agriculture and horticultural sectors) use these dynamics to attract the interest of early adopters so the new technologies or practices are implemented on their own farms.

One of the major tools used to aid the adoption of new technologies and practices is the use of scientific and demonstration trials.

Scientific trials are conducted to test the performance of particular treatments such as products and practices compared to existing or standard approaches, and to statistically demonstrate whether the treatment produced has a significant effect or not. In other words scientific trials are designed to prove an effect.

Demonstration trials, traditionally are used when it has been already established, in scientific trial, that a given practice or product works. Therefore demonstration trials are designed to show a proven effect.

Guide focus

Demonstration trials are designed to show a proven effect

Planning a demonstration trial

Generally there are several reasons why demonstration trials are implemented:

- **Industry driven:** There is a new product, practice or technology which is untried or lacks credibility and it needs evaluating in a new environment e.g. a composting industry introducing compost products to agriculture.
- **Farmer driven:** Information has been gathered from farmers over time where a problem or practice requiring an improvement has been identified. It involves collecting and analysing information to design trials and demonstrations.

Establishing a steering committee

Planning a demonstration trial should begin with the selection of a steering committee or group of people who can define, implement and oversee the management of a demonstration trial.

The reason for having a steering committee is to clearly define the trial's objectives, oversee time lines and provide expertise in the area being investigated

A committee is usually made up of three to five people including a farming body representative, the site provider, technical person (e.g. agronomist), manager of the demonstration and product reseller/producer. Many demonstration trials are undertaken in cooperation and partnership with a farming demonstration group, an industry farming body, consultants or farming service providers.

This committee should be made up of people who:

- are aware of the problems that need to be addressed
- have a knowledge of the product or practice e.g. compost
- can provide technical expertise
- can oversee the management requirements, time lines and finances
- can find a suitable co-operator (co-operator is often a committee member)
- are willing to attend meetings and help gather support for activities
- are able to promote the outcomes.

Choosing a participating farmer (co-operator) and demonstration site

The success or failure of a demonstration may well depend on the ability of the steering committee to find a willing farmer to participate that meets the acceptable criteria i.e. the objective of the demonstration.

Generally trial demonstrations are piloted by farmers (early adopters) wanting to see how a new product or practice performs at local level. Some of the attributes for a good co-operator is someone who is:

- local and well respected
- an early adopter or progressive
- a typical farmer or producer in the region
- likely to volunteer their farm site, time and machinery
- willing to loose some production or area of crop for demonstration purposes
- able to provide access for those managing the site
- willing to use their farm as a promotional tool for the outcomes of the trial.

Remember, the perfect co-operator is probably impossible to find. In some instances the manager of the trial/demonstration or the co-operator may require an agreement between both parties outlining the responsibilities and commitments to be made by both parties. This is nearly always done for scientific trials, but is important in demonstration trials.

Developing objectives

The most important aspect of any demonstration is to set the objectives of the trial (demonstration trials are designed to demonstrate a proven effect).

Ordinarily the reason for applying compost revolves around the amendment of soil problems linked to functions of organic matter, which in turn supports a plant response and is done so in a cost effective manner. Therefore any compost demonstration trial should consider that there may be three objectives.

Objective 1

Introduce the use of compost as a farming practice to maintain or improve soil health and/or functions

Objective 2

Maintain or improve crop whether it is yield, growth, quality and/or timing as a result of introducing a practice of using compost to maintain or improve soil health and/or functions

Objective 3

Introduce new compost practice cost effectively (cost benefit)

Determining the health of your soil

Soil testing is usually the management tool which helps determine or confirm the need to implement or maintain additions of organic matter. For example, soils high in organic matter are desired for vegetable production, although some loss of organic matter from vegetable growing soil is inevitable as decomposition is always going to occur. Vegetable growers have soil samples taken regularly to confirm their organic matter levels prior to planting.

Generally there are published parameters for determining whether there is an issue with your soil or to identify a problem for when to use or demonstrate the benefits of composts. Some of the following criteria are used from soil testing to determine if there is a problem in soils and hence farming production. If several of these parameters are deemed undesirable from history, observations and soil testing programs in production situations, then there is a case to look at the use of compost products being demonstrated.

- Carbon - < 2%
- Organic matter - < 2%
- Soil texture - sand
- CEC - < 2 meq /100g
- Slaking - high
- Sodicity e.g. sodium > 5 % cations
- Infiltration rates - high
- Salinity - high EC
- pH - very acidic
- Dispersion - dispersive
- Biology (low counts micro/macro flora - (FDA activity mg FDA/g soil/45 min)

Selecting your objectives

> Introducing the use of compost as a farming practice to maintain or improve soil health and/or functions

As outlined the first step is to select the soil function(s) you are anticipating to influence with the new farming practice using the application of compost. Note, if the new farming practice is replacing a current practice, the current practice will be your control for comparison and assessment of cost effectiveness. Below is a list of some of the proven soil improvements when adding compost to horticultural and agricultural crops.

- ☐ Water holding capacity
- ☐ Nutrient cycling
- ☐ Soil structure
- ☐ Soil temperature
- ☐ Soil microbial balance
- ☐ Organic carbon content

Note: Composts are primarily used for their soil conditioning properties and not their nutritional value although compost can help greatly in retaining nutrients once it is incorporated into the soil profile. In agricultural or horticultural demonstration trials the compost's nutritional value should still be considered in nutritional budgeting.

Other considerations

To help ensure the objectives are met, it may be helpful to also consider other components that may contribute to the success of any demonstration trial. Other design components to include that are additional to the above objectives may include:

- ☐ soil type (sandy, or lack of organic matter)
- ☐ amendment type, rates and application method (surface, incorporated)
- ☐ replacement/substitution practice if applicable (e.g. chicken litter)
- ☐ other applicable inputs (e.g. fertiliser)
- ☐ timing (e.g. summer broccoli).

> Maintain or improve crop whether it is yield, growth, quality and/or timing as a result of introducing a practice of using compost to maintain or improve soil health and/or functions

The second step is to select the crop response(s) you are anticipating will be influenced or require monitoring as a result of the application of compost. In particular, the crop attributes that contribute to revenue should be measured to assist in determining the cost effectiveness of the new practice. Below is a list of major crop responses proven during compost application trials in horticulture and agriculture.

- ☐ Yield
- ☐ Shoot and trunk growth (establishment young trees/vines)
- ☐ Macro and micro nutrient levels (within the plant/fruit)
- ☐ Fruit sugar content
- ☐ Growth rate (establishment of the crop)
- ☐ Tuber numbers - root growth
- ☐ Plant tillering (cereals)
- ☐ Dry matter production
- ☐ Root growth
- ☐ Tissue nutritional content

> Introduce new compost practice cost effectively (cost benefit)

The third step is to record the farm input and management costs and revenue received from the crop to assess the cost effectiveness of the new practice. This could be seen as the most important step as ultimately the cost will drive the final decision to embedding a new farm practice even if soil functions can be demonstrate to have improved and led to improved crops.

Designing the trial

Plots

In on farm demonstration trials, where treatments must fit in with a commercial operation, it is recommended to restrict the number of treatments to one or two (at most three). The remainder of the paddock, block or orchard could be kept as a control and managed under normal practice. A simple trial that produces a clear outcome is better than a very complex and time consuming trial that confuses the issue.

The objective of a trial is to learn something about how the crop responds to inputs. To ensure this happens treatments must be large enough to bring about a change in crop yield or quality or profitability.

In demonstration trials the treatments are not replicated or randomised as they are for scientific trials. If the demonstration treatment plots are large e.g. paddock like, then sub-sampling within the treatment plot several times could provide some replication or data which can be evaluated with some variability.

Control and treatments for on-farm demonstration trials

The control and the treated plot(s) differ only in the specific treatment comparison being made. Aside from this treatment, plots are managed exactly the same to avoid biasing results. The control allows the performance of products and costs/benefits to be assessed using conventional practices. In demonstration trials there are usually single treatments as shown in Table 1.

TABLE 1: EXAMPLE OF SINGLE TREATMENT LAYOUTS

Control	No compost
Treatment 1	Composted mulch applied at 2t/ha
Treatment 2	Composted mulch applied at 5t/ha
Treatment 3	Composted mulch applied at 10t/ha

Control Plots

Control plots represent the current practice applied by the producer. It does not receive the new input or practice being tested; rather it represents the current management input/practice used in the usual manner whether it is your tillage practice, fertiliser regime, variety and/or applied fungicide.

Treatments

The selection of treatments is usually logical if you can define the trial; all treatments necessary to address the trial's objectives should be included. The selection of treatments and the trial design get more complicated as the question you are trying to answer gets more complex. It is common to want to trial in the same experiment two (or more) things that influence crop production. For example, you may want to test compost as a fertiliser and test five wheat hybrids to maximize yield. The specific questions addressed in this case are:

- What effect does compost have on wheat production?
- What effect do the hybrids have on wheat production?
- Does compost have the same effect on each hybrid?

The third question may not be as obvious as the first two, but it will always be asked or implied if you are testing two or more factors in the same trial. In this example, you need to determine what the effect of compost is on each hybrid and then compare those effects to each other. To do that, the treatment list must include each hybrid without compost and each hybrid with compost (a total of 10 treatments). With this list of treatments, you can make the comparisons necessary to answer the three questions above.

Plot sizes and layout

With demonstration trials you can use small plots or field strips, the size and scale is dependent on the availability of machinery or labour to spread plant and harvest the crops. Many of the co-operators like to use their own machinery, so big areas are often preferred.

Small plots are used when hand applications or harvesting is necessary, when space is constraining, financing is stretched, and exposure is close to a road where it can be easily observed/promoted or when a large number of other treatments are involved.

Ideally, buffer zones should be included at the sides and the ends of the treatment plot to accommodate edge effects.

Field strips are generally confined to the one paddock but make up large areas within that paddock. Field strips should be used:

- where field equipment can readily be used for all plots
- for operations such as compost spreading, seeding, and harvesting
- where relatively few treatments are involved
- when method demonstrations under farming conditions is particularly important in gaining adoption of the practice.

Small plots have sampling points within the plot which may be a number of plants to the metre e.g. 20 plants/metre or it may be certain plant parts which are tagged and sampled. There is usually a number. In small plots generally all the area is harvested.

In large strip plots generally all the plot area is harvested by machine. Within the treatment plots you can have one or several areas to sample e.g. growth rates, tissue tests etc. In strip plots to cater for the variability it would be beneficial to have several sampling spots.

It is very important that the treatments and control are well fenced off or marked so that other farm management operations don't encroach on the demonstration site. All treatments and control should be pegged and if possible referenced with GPS co-ordinates. Poorly marked or pegged sites often result in a farm worker going over the trial with something not intended for the trial causing a cease of the demonstration because of corruption of the trial.

Choosing the compost product and application rates

Choosing the right product and application rates are critical to achieving a positive demonstration trial. Some compost products may not be suitable for phosphorus-sensitive plants or may require stock withholding periods. Discuss handling procedures and product suitability with your supplier.

Compost product characteristics

Composts generally have two characteristics that are important to be aware of as they may compromise the trial objective. These characteristics are maturity and particle size.

Maturity: Pasteurised or immature composts are still active composts and as such when applied to soil (in particular when undiluted) may compete for nitrogen which can lead to what is referred to as nitrogen draw down. In a production sense where the crop will be looking to utilise nitrogen for growth, it is advised to use a mature compost. Tests such as nitrogen draw down, carbon to nitrogen ratio and solvita maturity tests are important in determining the maturity level of a compost product.

Particle size: Coarse compost products are generally used for surface applications as mulches to conserve moisture, regulate soil temperatures, help with weed and erosion control and aid water infiltration. Finer texture materials have similar characteristics but can reduce infiltration of water if put on too thickly.

In addition, pasteurised and mature compost nutrient levels are relatively low when compared to other organic sources e.g. manures. Generally nitrogen, phosphorus and potassium concentrations are low. Composts are used for their soil conditioning properties and not their nutritional value although compost can help greatly in retaining nutrients once it is incorporated into the soil profile. In agricultural or horticultural demonstration trials the compost's nutritional value should still be considered in nutritional budgeting. Table 2 provides a range of analysis for compost. The nutrient variation can be due to the maturity, the type of material being composted and the time of the year.

TABLE 2: TYPICAL COMPOST CHARACTERISTIC RANGES

Characteristics	Units	Compost *
pH		6.6-8.3
Moisture content	%	25-55
Organic matter	DWt %	30-70
Total organic carbon	DWt %	15-35
Bulk density	Kg/m^3	0.6-0.75
C/N ratio		10-30
Nitrogen	DWt %	1-2
Phosphorus	DWt %	0.2-1.4
Potassium	DWt %	0.8-1.5
Screen size	typical size	≤16mm

Application rates

Application rates are dependent on the reason for using compost. Past trials and soils parameters have helped fine tune what rates of compost should be applied. Most of the present research suggests that there are three compost application rate regimes that can be applied for managing organic matter.

- To *increase* soil organic matter quickly, a capital application of at least 40 t/ha or 80 m^3 of compost is required.
- To *increase* soil organic matter slowly, a capital application of at least 20 t/ha or 40 m^3 of compost is required, every time the soil is tilled in preparation for a new crop.
- To *maintain* organic matter, a lower rate may be effective e.g. 5 – 10 t/ha or 10 – 20 m^3 of compost is required.

These rates may still be uneconomical for many farmers. Smaller rates used in conjunction with possibly lower rates of chemical fertilisers can still be useful for temporary improvements to soil health however longer term soil health requires routine additions of compost at rates in the order of 3t/ha or better.

Reporting compost characteristics

Typically, one demonstration trial on its own is not sufficient evidence to give confidence to the entire market however combining multiple demonstration trials over a longer time period can. Reporting on the compost type and characteristics (outlined in Table 2), as part of the trial, is as important as the results achieved. This will allow like for like products, used in multiple demonstrations trials, to be combined to≈provide confidence to the market.

Application rates and timing

The best time to apply any organic matter is when the soil is being prepared for establishing a new tree or vine planting, a winter or summer crop, renovating a pasture situation or working up beds for vegetables. Compost should be applied when conditions are dry and the land can be readily accessed by machinery to apply and work the material into the soil. Generally late summer to early winter is a good time. Some of the suggested rates for compost are listed below.

Annual crops (vegetables)

For annual crops, compost can be applied before sowing ideally one to two months ahead. This allows the compost to become integrated into the soil to commence soil conditioning and biological stimulation. Incorporate it into the top 10 – 20 cm of soil, either in a single application or split-up over the year. When using as mulch, apply 20 – 30 mm thick on the bed surface.

Perennial crops (fruit, nut, vines and berries)

In perennial crops, compost can be trenched into planting rows at a depth of 25 – 60 m^3/ha (10 – 30 t/ha approximately) whether for establishment, renovation or mounding. Compost can also be surface applied under perennial crops (e.g. trees, shrubs and vines) at 50 – 75 mm (coarse material) depth to 15 – 25% of land centred on the row. Fine material can be applied at 25 mm depth to 15 – 25% of land centred on the row and should never be applied at high rates (not higher than 50 mm).

Pasture

For perennial pastures, paddocks should be grazed down before compost is applied. This enhances contact with the soil surface and pasture re-growth will quickly shade the compost and prevent it drying out or blowing away. Top dressing rates vary between 2 – 15 m^3/ha or 1 – 7 t/ha.

Cropping

In cropping, compost can be used as a soil conditioner pre sowing ideally one to two months ahead of sowing at a range of 15 – 30 m^3/ha or 7 – 15 t/ha. The rates are very dependent on the cost of the compost in terms of cartage, spreading and the time to which farmers have access to compostable material on-farm, labour costs, machinery costs etc.

Promotion/dissemination

Once the trial is in progress or is showing outcomes, consider letting farmers and other community leaders know (by newsletter, signage, newspaper or word and mouth) that a demonstration is being conducted. When farmers are actively involved in on-farm demonstrations, they act as an avenue for the diffusion of new technology. Publicity of the demonstration should centre on:

- purpose of demonstration
- demonstration treatments
- access and time of demonstration evaluation.

Signs: The demonstration or field trial should have a prominent sign that is in place when the demonstration is initiated. Also use signs to identify each treatment. This is helpful to farmers and others who informally stop by to view the plots on their own time, as well as for any tour groups you might organise.

Publicity campaign: When treatment differences begin to show up and yield results give evidence of being consistent, begin a publicity campaign. An effective way to promote the demonstration is to have a field day, tours and meetings at strategic times (such as growing, spraying, harvest).

Photographs: Take plenty of pictures and videos, at all stages of the demonstration, to help document your project.

Website: Many of the demonstration farms (e.g. Birchip) and resellers have web sites were demonstration details and observations can be updated on a regular basis, especially photos etc.

Planning checklist

- [ ] I have established a committee
- [ ] I have developed my objectives
- [ ] I have a trial coordinator
- [ ] I have a co-operator
- [ ] I have designed the trial site
- [ ] I have chosen the right product
- [ ] I have the treatment parameters organised
- [ ] I have costed the measurements required
- [ ] I have a list of the management input requirements
- [ ] I have a promotion plan

Implementing a demonstration trial

Monitoring and measurements

In demonstration trials measurements are taken in various crop situations. Usually there are more measurements taken from scientific trials than a demonstration trail. The objectives selected will determine the measurements to be taken.

Measurement parameters and scheduling

What you will measure depends on the demonstration objectives. If the purpose of the trial is to improve soil structure then measure those parameters associated with improved soil structure. If the purpose is to also increase net farm profit, then you must also include costs and returns (including yield).

> Select the measurement(s) and scheduling that match the soil health and/or functions targeted for the application of compost to maintain or improve soil health and/or functions

Soil parameters measured for demonstrations can be based on past records or sampling prior to the trial and post harvesting the demonstration. Not all parameters are used, only those that align with the objective of the trial. Some of the measurement parameters for soils and common soil analysis and conversions are outlined in Appendix 1.

- ☐ Carbon %
- ☐ Organic matter %
- ☐ Soil texture
- ☐ CEC
- ☐ Slaking
- ☐ Sodicity sodium
- ☐ Infiltration rates
- ☐ Salinity pH
- ☐ Dispersion/dispersive
- ☐ Biology (FD activity mg FDA/g soil/45 min)

The soil sampling depth for any crop is based on the depth sampled when the soil test calibration experiments were conducted and generally relate to the zone of maximum feeding root activity. This will vary for each crop and pasture type.

In most situations, it is the topsoil which is of most interest when soil sampling. The topsoil is defined as the most recently formed soil, containing organic matter (humus) and is of highest nutritional value to plants. Most compost are applied to the soil surface, or incorporated into the top soil by cultivation.

It is this layer of soil in which the fibrous feeding roots of most crops are located. Top soil sampling depth varies depending on the crop grown, but generally ranges from zero to 25 cm.

Sub-surface sampling may also be necessary to check for salinity, sodicity, acidity and nutrient deficiencies or toxicities which may affect growth, particularly of deep rooted species. Sub-surface sampling may also be used in pasture and annual horticultural row crops when investigating areas susceptible to salinity or soil acidity and where structural problems may limit plant growth.

Table 3 outlines examples of sampling and timing for a variety of crops.

TABLE 3: EXAMPLE OF SAMPLING AND TIMING

Enterprise	Top soil	Sub soil	Sub soil	Time
Cropping	0 - 10 cm	10 - 30 cm	30 - 90 cm	Late summer/post harvest
Pasture	0 - 10 cm	10 - 30 cm	30 - 45 cm	Late summer - autumn
Vegetables	0 - 15 cm	15 - 30 cm	30 - 45 cm	2 - 3 month prior to planting
Fruit and grape crops	0 - 15 cm	15 - 30 cm	30 - 45 cm	Post harvest - spring

Select the measurement(s) that match the crop response(s) requiring monitoring as a result of the introduction of the compost practice

Measurements taken from crops being evaluated during the trial are dependent on what the crop is. There are different measurement criteria for vegetables compared to growing wheat or grapevines. Most times the measurements are yield, growth rates, quality parameters and economic considerations. The list below outlines some of the measurements taken in various agricultural and horticultural crops for trials purposes.

Major crop parameters to measure are yield, fresh and dry weight, growth rates, quality parameters and increases/decreases in physical or chemical status in the plants or soils.

- [ ] Yield
- [ ] Plants per sqm^2
- [ ] Dry matter
- [ ] Tissue analysis (cropping, pasture, vegetables, fruit and vines)
- [ ] Protein in the grain (cropping)
- [ ] Nitrogen (cropping)
- [ ] Pasture plate (pasture)
- [ ] Number of cuts (pasture)
- [ ] Total fresh weight (vegetables)
- [ ] Marketable fresh weight (vegetables)
- [ ] Plant count /m, fruit or tuber count
- [ ] Sap analysis (vegetables, fruit and vines)
- [ ] Plant count /m, disease free, colour, size and grades (vegetables, fruit and vines)
- [ ] Shoot growth & diameter (fruit and vines)
- [ ] Bunch count (fruit and vines)
- [ ] Fruit or berry size (fruit and vines)
- [ ] Brix (fruit and vines)

As part of the measurement taking you need to know the crop cycle, plant density, the stages of growth and the time taken for the crop to be sown, grown and matured.

Select the measurement(s) for assessing the cost benefit of the new compost practice

Its important to show the cost effectiveness of the new practice against the current practice, as this generally provides the most interest or selling point of the whole demonstration trial especially to farmers and growers alike.

- [ ] Yield revenue = (yield x price)
- [ ] Cost of compost = ($/t x t/ha)
- [ ] Water inputs megaliters/ha
- [ ] Nutrient inputs kg/ha of actual element e.g. nitrogen
- [ ] Spreading = (t/ha x spreading rate $/ha)
- [ ] Transport = t x $ x km
- [ ] Total cost = transport x spreading x rate
- [ ] Grower return = (yield x price) - [Yield x (cost of product + transport + spreading)]
- [ ] Labour costs

Other measurements

There are other measurements which can have an effect on soil conditions, growth and cropping ability which in turn affects the profitability of agricultural/horticultural production. These parameters must be recorded as they can often be used to explain the success or failure of the demonstration.

- [ ] Climate measurements: rainfall, temperatures, evaporation, frost
- [ ] Fertiliser inputs
- [ ] Irrigation inputs
- [ ] Pest and disease incidence
- [ ] Photos

Implementing trial checklist

- [ ] I have selected all the measurements I need to take
- [ ] I have developed and made recording data sheets
- [ ] I have created a schedule for taking all the measurements
- [ ] I have taken all the pre and to post trial measurements and samples I needed to take

Analysing demonstration trial

Data analysis

Analysis of the data should centre on the three measurement categories taken from the trial.

> Analyse the measurement(s) to improve or maintain a healthy soil

Soil data

Soil data covering off on the physical, chemical and biological aspects of the demonstration should include the base data taken pre-demonstration, as well as the data collected during and after the duration of the trial. Data is analysed and is expressed in tables and compared to benchmark data of the site and or known parameters developed by the industry. Often the results are expressed in percentage increases or decreases against the known benchmarks.

Photographs are often used to show the differences.

Sending samples to laboratories

Samples should be sent to a NATA accredited lab and should be made up of 20 - 30 cores from each treatment and control plot. The sampling sites should be marked or GPS referenced in order to collect from the same site in the future. Sample depths are dependent on the crop and the management application being demonstrated i.e. surface applied, mulching or deep soil incorporation of compost. See Table 3 for sampling depths of various crops.

It is important to recognise that even NATA laboratories will have a result bias i.e. a lab may provide slightly higher or lower test results compared to another. Therefore it is **important that all samples be sent to a single laboratory.**

The four main categories of soil physical and chemical attributes that influence soil fertility are:

- acidity (pH, aluminium, carbonates)
- salinity (EC, soil texture)
- structure (cations: calcium, magnesium, sodium, potassium; slaking, dispersion, organic matter)
- nutrients, including phosphorus, potassium, sulphur and magnesium.

For soil tests, the pH should always be conducted by two methods (pHw and pHc). A test for chloride salts should also be performed. For plant (nutrient) tests, leaf or petiole (grapevine) tests, include what's commonly known as the ICP suite: N, P, K, S, Ca, Mg, Cu, Zn, Mn, Fe, and B.

For yield quality, specific tests will be dictated by the crop e.g. juice quality parameters for vine yield, protein for grain, sweetness for corn, etc.

> Analyse the measurement(s) to improve or maintain crop response(s)

Crop measurements

After collecting measurement data from the sites the data should be collated on a regular basis to monitor the trends. Usually the data is summarised – analysed with simple average/means/percentages. The data is then transposed and summarised into summary tables, graphs or dot points for visual affect.

If there is a lot of data from the measurements and some replication was used in the demonstration, then statistical analysis may be possible especially if measurements were sub-sampled in large strip treatments in the same places several times (a form of replication). This data can be used and makes it possible to determine, with known probabilities of error, whether a difference is real or whether it might have occurred by chance.

Simple statistical software packages are available. Microsoft Excel has a very good analysis of variance procedure.

Statistical analysis should be done by someone with the technical expertise, seek out help when at the planning stage.

Photographs are often used to show the differences.

Analyse the measurement(s) for assessing the cost benefit of the application of compost and resulting crop responses

Profitability

It is important to show the profitability or cost of the treatments results or failures. You can use partial budget analysis in agricultural situations as growers can generally relate to the basic costs of the inputs. Generally this cost benefit analysis is based on the following and is the most important.

- [ ] Transport cost (cost per cm^3 or tonnes)
- [ ] Spreading cost (cost per cm^3 or tonnes)
- [ ] Cost of product (cost per cm^3 or tonnes)
- [ ] Rate applied (kg, cm3, t per/ha)
- [ ] Yield (kg, catons, bins, t /ha)
- [ ] Price of the crop ($, kg, catons, bins, t)

Again, this can be expressed in simple summary tables or graphs for the treatments.

Profitability: Current farm practice vs. new farm practice

It is important to show the profitability or cost effectiveness of the new practice. You can use partial budget analysis in agricultural situations as growers can generally relate to the basic costs of the inputs or gross margin analysis. It is very important to analyse the results of the trials as the economic viability is a critical factor which will determine the future uptake of delivering and spreading large amounts of compost into to agriculture and horticultural markets.

New practice grower return = (Yield x Price) - [Yield x (cost of product + transport + spreading)]

Versus

Current practice grower return = (Yield x Price) - [Yield x (cost of product + transport + spreading)]

Reporting

Write up a consolidated report of the demonstration covering off on the organisations/individuals involved, the planning process, the contacts, co-operator, the site history, the objectives, the site location and design, the measurements and data obtained, the outcomes and profitability and any recommendations (see Appendix 2). Any other information which is thought to be useful can be included in an appendix at the end of the report. These reports are often used as reference materials for future demonstrations or promotions.

The most important part of the report is to produce a one to two page executive summary (if possible) containing a brief background of the demonstration objectives, the site and treatments, the duration time, the manager and co-operator contact details and the outcomes with benefits in either dot point, tables or graphs. This document aids the extension and promotion/marketing of the benefits created by the demonstration trial. It should be a document which is easy to comprehend.

The one to two page summaries should centre around the benefits covering off on the objectives of the demonstration i.e.:

- soil measurements: physical, chemical and biological
- crop measurements: yield, growth, quality etc.
- profitability: current practice vs. new practice.

Summary

One of the major functions of using trials and demonstration trials is disseminating useful and practical information. On-farm demonstrations serve as one of the most effective marketing/education tools ever developed for agriculture/horticulture. Although partial scientific trails and demonstrations require considerable time and effort, the payback comes when producers more readily adopt practices they perceive to be appropriate under local conditions. This is known as "seeing is believing."

Demonstration trials should not be casually developed or implemented. Instead, as their name implies, demonstrations should have predictable outcomes based on sound research foundation. Demonstrations should illustrate the application of appropriate technology or practice, that is, technology or practice that fits the local set of conditions. When this occurs, the maximum learning will result from the resources invested.

Glossary

Bulk density
Weight or mass per unit of volume of a material comprised of many individual particles. For example, the weight of a pile of wood chips divided by the volume of the pile is the bulk density. This is different from the particle density (which, in this case, equals the weight of a single wood chip divided by its volume)

Cation
An ion with a positive charge.

Cation exchange capacity (CEC)
The total amount of exchangeable cation, or the ability of negatively-charged clay minerals to hold cations, often referred to as the CEC. A guide to the nutrient status and structural resilience of a soil.

Compost
An organic product that has undergone controlled aerobic and thermophilic biological transformation through the composting process to achieve pasteurisation and reduce phytotoxic compounds, and achieved a specific level of material required for compost (AS4454 – 2012).

Dispersion
Disintegration of soil aggregates into single soil particles upon wetting; the opposite of flocculation.

Infiltration
The movement of water into a soil.

Nitrogen drawdown index
A measure of the ability of a composted organic product to supply soils and/or plants with soluble nitrogen. See also immobilisation, nitrogen.

Nutrients
Required for good plant growth, e.g. nitrogen, phosphorus and potassium.

Organic matter
Living and dead plant and animal material.

Pasteurisation
A process whereby organic materials are treated to significantly reduce the numbers of plant and animal pathogens and plant propagules (AS4454 – 2012).

pH
A measure of how acidic or alkaline a soil is.

Salinity
An excess of water-soluble salts (dominantly sodium chloride in Australia) that restricts plant growth, indicated by electrical conductivity.

Slaking
Collapse of aggregates into microaggregates upon wetting.

Sodicity
An excess of exchangeable sodium causing dispersion to occur.

Water-holding capacity
The amount of water held in a soil after any excess has drained away following saturation, expressed as a percentage of the oven-dry weight of the soil.

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Declan McDonald, Kevin Wilkinson, Sally Stead
DEPI Victoria January 2014

Compost Market Development Project
Project Manager: Steven David Organic Farming Systems
O Box 419, Cottesloe WA 6911

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Considerations when conducting field trials involving recycled organic products, Replicated and Demonstration Trials Commissioned By Brock Baker Sustainability Victoria
prepared By: Siegfried Engleitner © Sustainability Victoria

Appendix 1: Common Soil analysis calculations and conversions

Concentration

milligram per kilogram - mg/kg = ppm (parts per million)

kilogram/hectare - kg/ha = 1.12 x lb/ac (pounds per acre)

EC = Electrical conductivity

(1:5 soil:water) dS/m is the same as millisiemens/centimetre (mS/cm)

EC_{se} = EC (1:5) x texture class and soil chloride conversion factor

Common measurement correlations to decisiemens per metre (dS/m)

- dS/m = mmho/cm = mS/cm (decisiemens per metre = millimho per centimetre and millisiemens per centimeter - all of which are equivalent measurements)
- dS/m x 100 = mS/m (decisiemens per metre by 100 = millisiemens per metre)
- dS/m x 1000 = µS/cm (decisiemens per metre by 1000 = microsiemens per centimetre)
- dS/m x 640 = ppm = mg/L = µS/ml1 (decisiemens per metre by 640 = parts per million AND milligrams per litre AND micrograms per millilitre. These measure total dissolved salts/solids)
- dS/m x 0.34 = % total soluble salts (TSS) in 1:5 mix (% TSS in an EC1:5 mix at 25oC)

To convert from an EC in dS/m to ppm, the factor varies from 530 to 900 depending on the type of salt and its concentration. The figure of 640 is used here as an accepted average.

Organic matter

May be estimated by multiplying organic carbon % by 1.72

Cation exchange capacity

Cation exchange capacity (CEC) meq/100g (milli equivalent per 100g) is really only an estimate, so should be referred to as "effective cation exchange capacity".

- It is calculated as the sum of the exchangeable cations in meq/100g, i.e. $K^+ + Ca^{2+} + Mg^{2+} + Na^+ + Al^{3+}$
- In acid soils, additional cations may be important, these are : H^+ (hydrogen), Fe^{2+} and Fe^{3+} (iron) or Mn^{2+}, Mn^{3+}, Mn^{4+} (manganese)
- In soils where pH (water) is > 6.0, aluminium is usually insignificant - it is insoluble and is not analysed
- In alkaline soils, the only additional cation which may be important in some situations is NH_4^+ (ammonium)
- Hence in alkaline soils, the effective CEC is calculated as: - CEC = K + Ca + Mg + Na. (NH_4^+ is not measured)

Sodium percent of the cations

Sodium per cent of cations or ESP (exchangeable sodium per cent) -

$$\text{Na\%} = \frac{\text{Na (meq/100 g) x 100}}{\text{CEC (meq/100 g)}}$$

Aluminium percent of the cations

Aluminium per cent of cations or aluminium saturation -

$$\text{Al\%} = \frac{\text{Al (meq/100 g) x 100}}{\text{CEC (meq/100 g)}}$$

Ratios

These can only be calculated when nutrient contents are given in the same units. For example, the calcium to magnesium ratio (Ca:Mg) is calculated as follows:

$$\frac{Ca^{2+}\ \text{meq/100g}}{Mg^{2+}\ \text{meq/100g}}$$

Appendix 2: Trial report layout

Trial Report

Title	Name
Date	Start date
Trial coordinator	Name(s)
Contact details	Address, email address, phone numbers etc
Co-operator	Name(s)
Contact details	Address, email address, phone numbers etc
Aim	Purpose of the trial
Background	Past farming management practices and inputs
Description	Farming practices
Site	Location GP coordinates
Products	Description
Treatment (s)	Description
Trial/demonstration/design	Map
Measurements	List measurements undertaken and when
Management inputs	List inputs and date e.g. rainfall, weedicide application etc.
Activity sheet	Summary of management activities
Recording data	Measurements and dates
Observations	Visual observations rainfall, photos
Analysis of data	Summary table's graphs and statistical analysis
Interpretation	Discussion data
Summary key points	Conclusions (recommendation)
Appendix	Raw data, references calendar date etc.
Promotion	Fact sheets, web, CD, newsletter, brochure, marketing kit

Appendix 3: Useful websites

www.grdc.com.au

www.ausveg.com.au

www.vff.org.au

www.ngiv.com.au

www.australiangrapes.com.au

www.vicstrawberry.com.au

www.vgavic.org.au

www.driedfruitsaustralia.org.au

www.mvwi.com.au

www.fgv.com.au

www.cherries.org.au

www.summerfruit.com.au

www.arga.com.au

www.abga.com.au

www.onionsaustralia.org.au

www.asparagus.com.au

www.melonsaustralia.org.au

www.citrusaustralia.com.au

www.almondco.com.au

www.chestnutsaustralia.com.au

www.australianolives.com.au

www.walnut.net.au

www.pgai.com.au

www.organicfarming.com.au

www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil-home

https://ausveg.worldsecuresystems.com/enviroveg/programs/healthysoil.htm

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Sustainability Victoria
Level 28, Urban Workshop,
50 Lonsdale Street, Melbourne VIC 3000
Phone (03) 8626 8700
sustainability.vic.gov.au

Published by Sustainability Victoria.
Conducting Compost demonstration trials in agriculture/horticulture