# Hort360 Reef Certification Interpretive Guideline



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Hort360 Reef Certification
Interpretive Guideline
2020
Growcom Australia

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Contents



Overview

The aim of this document is to provide guidance to auditors and growers on interpreting the requirements of the Hort360 Reef Certification.

Appendix 1 provides technical support on a per question basis to assist growers implement desired outcomes.

*Appendix 1*

*Technical support per question*

*Mapping*

To develop a map series you are able to either complete this electronically and / or on paper.

A property map is required to identify property areas, infrastructure and surrounding areas.
A property map can be aerial photographs, topographical maps, cadastral maps, self-drawn maps or overlays that document and define the required features, infrastructure and natural resources on or adjacent to the property.

You will need to identify your property features on your property map.

The map identifies:

- Property boundaries, roads and surrounds (farming, school, sports fields, residential, etc.)
- Drainage lines and discharge points
- Natural waterways, wetlands, riparian areas and lakes
- Areas that are, or are at risk of being, highly degraded, eroded or contaminated
- Contours
- Various soil types / production areas / management zones

Management zone

A block, group of blocks or part of a block with similar features, yields and management history. Zones may be defined by soil type, topography and other identifying areas that determine management practices, including soil/leaf/sap/fruitlet tests, fertiliser recommendations, sediment, and water and erosion control.

Soil mapping

Soil maps may be available through government departments, natural resource management groups and/or professional agronomy advisors. You can also access soil maps for your property through the Queensland Globe. Soil map/s describing the soil types and boundaries relevant to a farm are useful references, and when combined with growers' existing knowledge, can be used to identify the areas from where to collect soil samples as the basis to develop a soil sampling plan.

Soil information and data – QGlobe fact sheets and online webinar

https://www.hort360.com.au/wordpress/wp-content/uploads/2020/02/Where-to-look-for-soil-information.pdf

https://www.hort360.com.au/wordpress/wp-content/uploads/2020/07/Queensland-Globe-How-to-access-soils-information.pdf

https://www.youtube.com/watch?v=ckbUz1ovbi8&feature=youtu.be

https://www.hort360.com.au/wordpress/wp-content/uploads/2020/02/Soil-information-and-data-online-webinar.pdf

www.qglobe.information.qld.gov.au/

# Nutrient Management

### Do you conduct soil / leaf / sap / fruitlet testing?

Soils are analysed for a variety of reasons including describing their inherent chemical, physical and biological properties, matching specific plant species and cultivars with soil characteristics, assessing organic and inorganic contaminants and accumulation, determining nutrient availability, monitoring changes due to inputs and management and assessing environmental risk.

Soil testing is central to any variable rate system. Based on the resolution of your management zones different soil sampling techniques can be used. The more samples collected in a field, the more accurate the management zone.

Plant tissue analysis is a part of the science of plant nutrition. It has been developed by analytical chemists in laboratories working in association with agronomists and horticulturists in the field. Plant tissue analysis acts as an early warning system, to highlight any nutrients that may be lower or higher than the optimal or normal range or which may affect crop yield potential and/or quality. It can also be used to help determine reasons for poor growth. With analysis systems, plant tissue testing measures the concentration of the nutrients in plant tissue, for comparison with the concentrations required for optimum plant growth and yield.

Plant tissue analysis is normally used for one of two main reasons:

1. Diagnostic - to determine the reason for poor growth - or trouble-shooting.
2. Monitoring - to assess the suitability of current fertiliser management practices.

Resource:

https://www.hort360.com.au/wordpress/wp-content/uploads/2019/11/Sampling-Procedure-Plant-Tissue.pdf

https://www.hort360.com.au/wordpress/wp-content/uploads/2019/11/Fertcare-Soil-Sampling-Guide.pdf

### Do you undertake nutrient target setting / budgeting?

For many horticulture crops the actual nutrient requirement per hectare is unknown. Of the data that is known, much of it is old (30 – 40 years) and may not directly relate due to varietal changes, growing conditions and management practices. Whilst the development of nutrient budgeting to its fullest extent is the preferred option growers could take initial steps to at least identify a target application and record against this.

Nutrient budgeting can help growers better understand the whole nutrient cycling and transformation system. This can lead to the design of more sustainable, integrated nutrition strategies. A nutrient budget is like an accounting system for nutrients. It involves:

- estimating the amount of nutrients available from the soil (soil test results)
- obtaining uptake and removal figures for the target crop and the previous crop (to account for nutrients in crop residues, for example, consideration should also be given to the contribution of legumes to nitrogen availability). Figures should be in kg/tonne of crop grown (for uptake) and harvested (for removal)
- determining the target yield to calculate actual uptake and removal figures;
- calculating the amount of nutrients, especially nitrogen, that will be applied with irrigation water (50 ppm nitrate in irrigation water will add about 1 kg N/ha with every 10 mm of irrigation water applied);
- calculating the amount of nutrients already applied to a paddock
- estimating the amount of nutrients that will be removed through harvested product
- determining possible nutrient losses through leaching, volatilisation or soil erosion. Deep soil nitrate testing can be an important tool in assessing leaching
- replacing nutrients lost to the system through appropriate fertiliser applications

Nitrogen, phosphorus and other major nutrients are the main elements considered in nutrient budgeting. Along with soil, leaf and sap testing and visual assessments, nutrient budgeting is another tool for fine-tuning the nutrient management program. A nutrient budget should be prepared for a 3–5 year rotation. Break or cover crops should be considered as ‘catch crops’. Nutrients that have not been used by the previous crop will be taken up by the break crop, thus avoiding leaching past the root zone. Reviewing local research and advice from agronomists can also assist in determining fertiliser requirements, particularly in situations where key information such as crop nutrient removal rates are not known. It is also important to determine if any nutrients are required in “luxury” amounts (that is over and above the nutrient removal figures). For example, potassium may be applied at higher rates because of its role in preventing bruising.

Resources:

https://www.hort360.com.au/wordpress/uploads/Nutrient/Decision/Cracking%20the%20Nutrient%20Code%20optimized.pdf – refer to section 3.4 Nutrient Budgeting, Page 26-27

https://www.hort360.com.au/wordpress/wp-content/uploads/2019/11/Principles-of-Nutrient-Management.pdf

https://www.hort360.com.au/wordpress/wp-content/uploads/2020/06/Soil-Wealth-Fertiliser-Program.pdf

https://www.hort360.com.au/wordpress/uploads/Nutrient/Management/Sustainable%20nutrient%20management.pdf

Table 1: Crop Nutrient Removal as adapted from the Australian Soil Fertility Manual

| Crop | Yield kg/ha | N | P | K | S | Ca | Mg | Cu | Fe | Mn | Zn | B | Mo | Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kg/t product | | | | | | g/t product | | | | | | |
| Apple[10, 16] | 45000 | 0.89 | 0.4 | 2.2 | | *0.08* | *0.09* | | | | | | | f |
| Avocado - Fuerte[16, 17] | 10000 | 1.13 | 0.17 | 1.95 | 0.8 | 0.21 | 0.5 | 1 | 9 | 2 | 4 | 4 | | f |
| Avocado - Lula[16] | 10000 | 2.8 | 0.35 | 4.53 | | 0.24 | 0.11 | | | | | | | f |
| Banana**[22] | 21000 | 2.9 | 0.95 | 10.5 | | | | | | | | | | f |
| Banana[10, 5] | 28000 | 3.8 | 0.6 | 15.6 | 1.9 | *8.8* | *3.3* | | | | *24* | | | f |
| Black currant[17] | 10000 | 2 | 0.5 | 4.4 | 0.4 | 0.8 | 0.3 | | | | | | | f |
| Coffee - Arabica***[16] | | 22 | 2 | 16.9 | | 1.5 | 2 | 13.6 | 61 | 20 | 12 | 16 | 0.05 | n.s. |
| Grapefruit[16] | | 1.06 | 0.13 | 2 | | 0.41 | 0.11 | 0.5 | 3 | 0.4 | 0.7 | 1.6 | | f |
| Kiwi fruit[17] | 25000 | 1.84 | 0.24 | 3.2 | 0.2 | 0.32 | 0.16 | | | | | | | f |
| Lemon & Lime[16] | | 1.64 | 0.16 | 1.73 | | 0.47 | 0.13 | 0.3 | 2.1 | 0.4 | 0.7 | 0.5 | | f |
| Macadamia[10] | 3000 | 10.7 | 1.3 | 5.7 | | | | | | | | | | f |
| Mandarin[16] | | 1.53 | 0.16 | 2.05 | | 0.5 | 0.11 | 0.6 | 2.6 | 0.4 | 0.8 | 1.3 | | f |
| Orange[10, 16] | 56000 | 1.8 | 0.2 | 1.9 | | *0.72* | *0.22* | *0.6* | *3* | *0.8* | *1.4* | *2.8* | | f |
| Passion fruit[17] | 15000 | 4 | 0.4 | 1 | 0.27 | | | | | | | | | f |
| Peach[19] | | 1.29 | 0.15 | 1.7 | | 0.06 | 1 | | | | | | | f |
| Pear[16] | | | 0.56 | 0.07 | 1.32 | | 0.23 | 0.12 | | | | | | f |
| Persimmon[17] | 25000 | 0.84 | 0.24 | 1.8 | 0.1 | 0.2 | 0.07 | | | | | | | f |
| Pineapple[25] | | 0.83 | 0.14 | 1.75 | 0.07 | 0.12 | 0.11 | | 5 | 0.3 | | | | f |
| Rasberry[17] | 10000 | 5.7 | 0.8 | 5.2 | | | 0.8 | | | | | | | f |
| Strawberry[17] | 30000 | 1 | 0.18 | 1.33 | | 0.17 | 0.1 | | | | | | | f |
| Tamarillo[17] | 16000 | 3 | 0.38 | 3.19 | | | 0.19 | | | | | | | f |
| Tea (plucks)****[16] | | 40 | 5 | 19.9 | | 5.7 | 2.5 | 40 | 200 | 850 | 40 | 30 | | n.s. |

| Crop | Yield kg/ha | N | P | K | S | Ca | Mg | Cu | Fe | Mn | Zn | B | Mo | Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kg/t product | | | | | | g/t product | | | | | | |
| Beetroot[10] | 6900 | 3.3 | 0.44 | 3.88 | | | | | | | | | | 85.7 |
| Broccoli[10] | 7000 | 21.1 | 3.2 | 15.7 | | | | | | | | | | f |
| Broccoli[1] | | 4.5 | 0.9 | 4.6 | 0 | 0.4 | 0.2 | | | | | | | |
| Cabbage[11] | 50000 | 2.9 | 0.48 | 2.9 | | 0.72 | 0.26 | | | | | | | f |
| Cabbage Dutch[1] | | 3 | 0.4 | 2.7 | 0 | 0.6 | 0.2 | | | | | | | |
| Capsicum[11] | 20000 | 2.1 | 0.2 | 3.45 | | 2.6 | 0.35 | | | | | | | f |
| Capsicum[1] | | 3 | 0.3 | 2.9 | 0 | 0.1 | 0.2 | | | | | | | |
| Carrot[11] | 44000 | 2.3 | 0.32 | 2.1 | | 0.34 | 0.14 | | | | | | | f |
| Carrot[1] | | 2 | 0.4 | 3.7 | 0 | 0.6 | 0.5 | | | | | | | |
| Cauliflower[11] | 50000 | 3.6 | 0.56 | 4.5 | | 2.5 | 0.36 | | | | | | | f |
| Cauliflower[1] | | 4 | 0.5 | 3.3 | 0 | 0.4 | 0.2 | | | | | | | |
| Celery[11] | 190000 | 1.6 | 0.42 | 3.68 | | 1.53 | 0.2 | | | | | | | f |
| Celery[1] | | 3.5 | 0.9 | 6.6 | 0 | 1.9 | 0.3 | | | | | | | |
| Cucumber[11] | 18000 | 1.6 | 0.28 | 2.5 | | 0.22 | 0.11 | | | | | | | f |
| Cucumber[1] | | 1 | 0.4 | 1.5 | | | | | | | | | | |
| Green Bean[11] | 4500 | 35.6 | 0.89 | 2.22 | | 0.44 | 0.44 | | | | | | | f |
| Bean green[1] | | 4 | 0.9 | 3 | 0 | 0.4 | 0.3 | | | | | | | |
| Lettuce[11] | 50000 | 2 | 0.36 | 3.6 | | 0.66 | 0.3 | | | | | | | f |
| Lettuce[1] | | 3 | 0.4 | 3.3 | 0 | 0.7 | 0.2 | | | | | | | |
| Lettuce oakleaf[1] | | 2.5 | 0.3 | 3.2 | 0 | 0.6 | 0.2 | | | | | | | |
| Onion[12] | 6500 | 1.8 | 0.4 | 2 | 0.5 | 0.4 | 0.12 | 0.6 | 13 | 6 | 5 | 1.3 | | f |
| Pea green[1] | | 5 | 0.7 | 3.3 | 0 | 0.6 | 0.4 | | | | | | | |
| Potato[11] | 40000 | 3.3 | 0.38 | 4.5 | | 0.25 | 0.08 | | | | | | | f |
| Pumpkin[1] | | 1.8 | 0.4 | 2.5 | 0 | 0.4 | 0.2 | | | | | | | |
| Spinach[26, 21] | | 3.9 | 0.3 | 4.6 | | 0.68 | 0.29 | *0.47* | 24 | *3.5* | 2 | *3.9* | *0.5* | 92.2 |
| Spinach[1] | | 4.2 | 0.6 | 0.6 | 0 | 1.3 | 0.6 | | | | | | | |
| Sweetcorn[1] | | 4 | 0.9 | 4.4 | 0 | 0.1 | 0.4 | | | | | | | |
| Sweet Potato[11] | 24000 | 2.5 | 0.58 | 3.8 | | 0.21 | 0.13 | | | | | | | f |
| Tomato[11] | 57000 | 1.4 | 0.58 | 2.6 | | 0.11 | 0.14 | | | | | | | f |
| Tomato[11] | 194000 | 1.9 | 0.43 | 3.2 | | 0.17 | 0.15 | | | | | | | ff |

** banana - removal includes 4 t/ha cull fruit and stems in addition to 21 t/ha fruit

*** coffee - removal for N, P, K, S, Mg & Ca is from Papua New Guinea data, micro-nutrient removal is from Brazilian data

**** tea - removal figures are for marketable tea produced

Moisture % - n.s = not specified, f = fresh weight

Values in italics - see note (b)

Notes:

(a) The data in the Table Appendix 1 have been derived from Australian sources, where available. Many of the data sources included measurements from different seasons and regions or were expressed as a range of values. The average of the range has been given, unless otherwise stated.

(b) The figures shown in italics are from the second reference listed

(c) Blank spaces indicate the lack of available data

(d) Figures indicate the approximate content of nutrients contained in the harvested portion at the indicated yield and are for the fresh weight of the produce, except where indicated. The actual moisture content or the assumed moisture content is shown. The figures do not include leaf, stem or vine of vegetable crops, except where indicated.

(e) Moisture content. A number of sources record nutrient content on an "as harvested" basis the following formula has been used: Nutrient content (as harvested) = nutrient content (oven dry) x ([100 - % moisture]/100)

(f) The ratio of grain to straw, tops to root, etc., is not constant. Thus, if a 2t/ha wheat crop removes 45 kg N, 6 kg P & 9 kg K, it does not necessarily follow that a 4 t/ha crop will remove double these amounts

(g) Nutrients may continue to be taken up if they are present in the soil solution, even if those nutrients are not needed by the plant. This is referred to as luxury consumption and applies particularly to potassium.

(h) In much overseas literature, the uptake of phosphorous and potassium are often shown as the quantity of P2O5 and K2O removed per hectare.

(i) Removal of nutrients by the harvested portion varies with size of crop, crop variety, soil fertility and seasonal conditions.

(j) Management of the crop or its residues can also affect the amount of nutrients removed from the soil.

References:

1 - Soil Wealth Fertiliser Program pdf - https://www.growcom.com.au/wp-content/uploads/2019/11/Soil-Wealth-Fertiliser-Program.pdf

5 - Dalal RC and Probert ME (1997) Soil nutrient depletion. In Sustainable Crop Production in the Subtropics: An Australian Perspective (Eds AL Clarke and PB Wylie), pp 42-63 Department of Primary Industries, Queensland.

10 - Moody P (1993). DPI (Qld) Nutrition in Horticulture Workshop (unpublished data).

11 - Cresswell GG and Heut DO (1995) Plant nutrition. In Vegetable Growing Handbook, Department of Agriculture New South Wales, Sydney.

12 - Sparrow L (1999) (pers. comm.).

16 - Halliday DJ, Trenkel ME and Wichmann W (eds) (1992) IFA World Fertiliser Manual. International Fertiliser Industry Association, Paris

17 - Clarke CJ, Smith GS, Prasad M and Cornforth IS (Eds) (1986) Fertiliser Recommendations for Horticultural Crops. Ministry for Agriculture and Fisheries, Wellington, NZ.

19 - Huett DO and Stewart GR (1999) Australian Journal of Agricultural Research 50: 211-215.

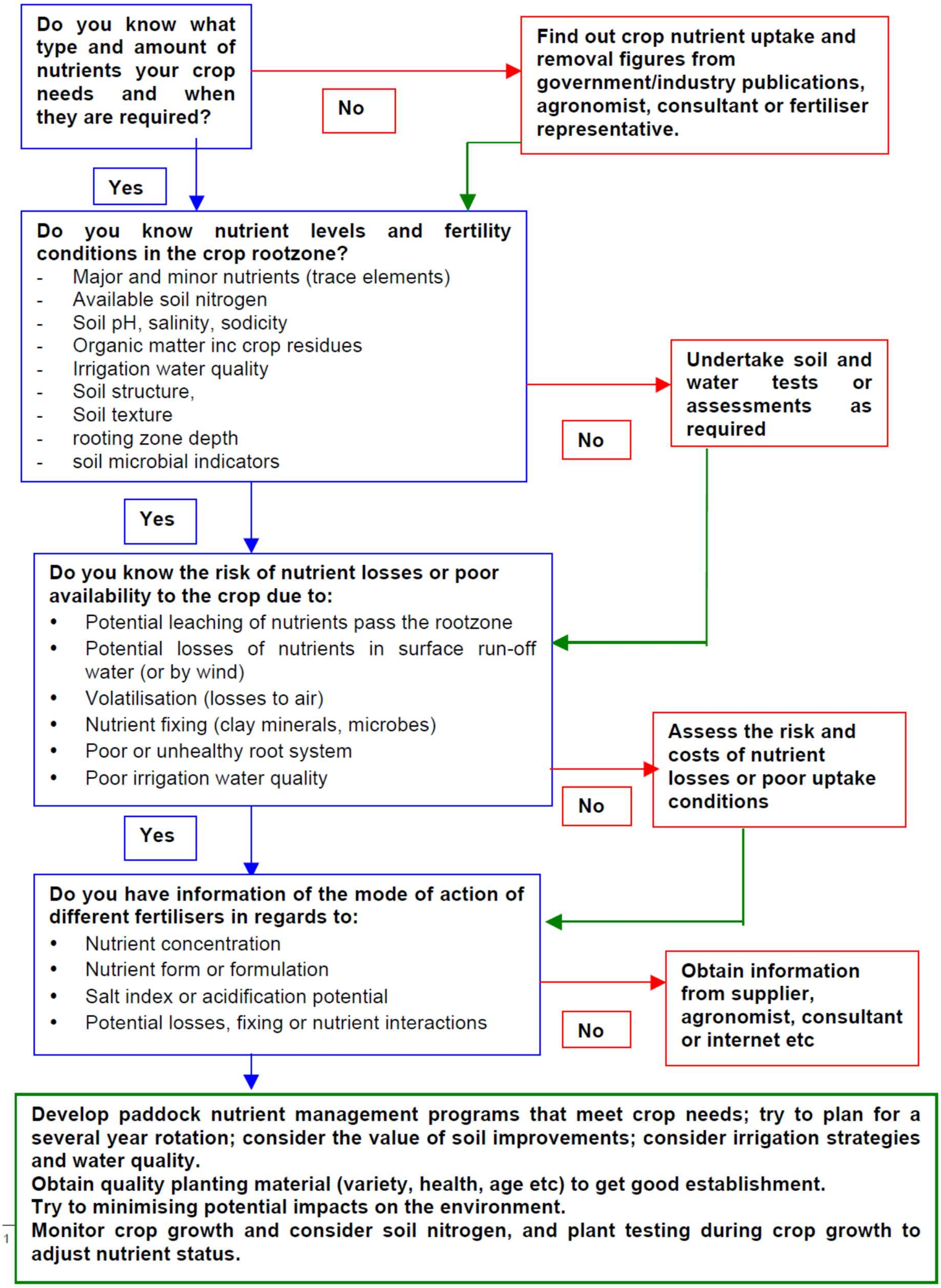
21 - Reuter Robinson (Eds) (1997) Plant Analysis: an Interpretation Manual (2nd Edition). CSIRO Publishing: Melbourne

22 - Vimpany et al. (1995) Fertlising Bananas in NSW (2nd Edition). NSW Agriculture

25 - Canas J. Golden Circle (1999) (unpublished data).

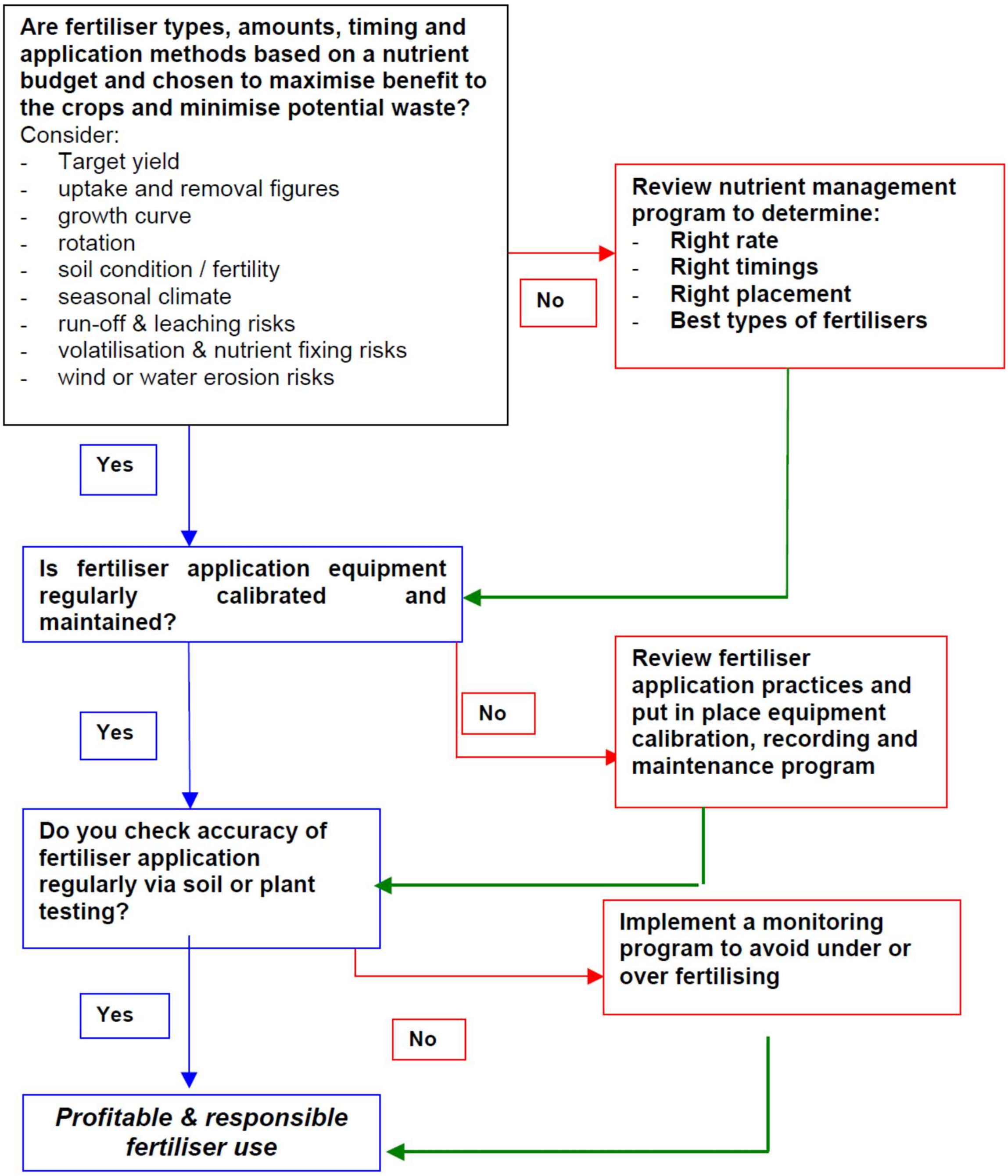
26 - Cashel et al. (1989). Composition of Foods Australia. AGPS: Canberra.

# Nutrient management decision guide[1]




1

## Fertiliser application decision guide[2]




[2] This and previous diagram was adapted from: Guidelines for Environmental Assurance in Australian Horticulture, published by Horticulture Australia Limited

What method of fertiliser application do you use?

We know and understand that growers potentially use a number of methods to apply fertiliser depending on the product, the weather and potentially the skilled labour on farm. The method used and the volume applied will directly relate to the risk posed. So a little often compared to large amounts infrequently will reduce the risk of losing fertiliser to the environment and ensure good uptake and use by the crop.

There are various methods of applying fertiliser to horticulture crops – fertigation, broadcasting granules, incorporated basal, banding and foliar.

Fertigation is the easy way for growers to split fertiliser applications and apply nutrients in regular small doses. However, fertigation can limit the area of soil which is treated with fertiliser to a narrow band around the irrigation line, which may not be adequate to feed the roots of the entire tree.

Depending on the fall of the land and irrigation equipment set-up, fertigation may also result in uneven nutrient application. Fertiliser will not be uniformly applied unless the irrigation water is uniformly distributed.

In macadamias, for example, the total nitrogen requirement should be split into five or more applications between April and October.

In avocados, the general recommendation is to apply 40% of the fertiliser requirement after fruit drop, another 40% four to six weeks later and the remainder when the flush is maturing, around April.

Resource:

https://www.hort360.com.au/wordpress/uploads/Nutrient/Management/Fertigation%20Management.pdf

https://www.hort360.com.au/wordpress/uploads/Nutrient/Management/Fertigation%20System%20Performance.pdf

https://www.hort360.com.au/wordpress/uploads/Nutrient/Application/Fertigation%20Compatability%20and%20Solubility.pdf

https://www.hort360.com.au/wordpress/uploads/Nutrient/Decision/Cracking%20the%20Nutrient%20Code%20optimized.pdf – refer to page 38

At what rate do you apply fertiliser?

Nutrient application practices enable different crops (beans, capsicums, avocadoes) to be managed separately and receive fertiliser according to their need rather than fertiliser being applied in a blanket approach.

Conventional methods of fertiliser application treat all areas of a block uniformly. Blocks, however, are not uniform and nutrient uptake is impacted by a multitude of factors that may vary across a block including slope, soil type, drainage, and organic matter content. A single application rate can result in the inefficient use of fertilizer as some parts of the block will receive sub-optimal nutrient inputs and others will receive more inputs than needed. Variable rate fertilizer (VRF) application is a precision agriculture technology that considers the diverse requirements within a block allowing for better placement of nutrients and consequently, improved nutrient uptake. VRF application results in input cost saving from less wasted fertiliser, and reduced nutrient loading to ground and surface water.

VRF application allows greater in block precision management through the use of management zones. Management zones are determined based on variables such as yield maps, soil maps, topography, and soil test results. Once management zones are established and added to the GPS/RTX database the optimal fertiliser requirements are prescribed either by the farmer or an advisor. Rates can be controlled manually or through rate control technology, which instructs the equipment to apply fertiliser at predetermined rates throughout the various management zones.

Soil testing is central to any variable rate system. Based on the resolution of your management zones different soil sampling techniques can be used. The more samples collected in a block, the more accurate the management zone. Bulk soil sampling typically consists of one soil test per 10 hectares. Grid sampling consists of one sample per grid unit. Grids can be set at various sizes but remain constant across a field. Zone sampling uses predetermined zones based off various data sets, which may include yield data, satellite imagery and topography. At least one soil test should be done in each zone. Soil test results can be used to evaluate management zones and to prescribe fertiliser application rates.

Resource:

Refer to Hort360 Reef Certification Forms / Templates for guidance on required record information relating to nutrient application:

- Fertilisers and soil additives application record and;
- Hydroponic nutrient solution monitoring record

Queensland Agriculture, 12/01/2016, "Prescription mapping for variability in vegetables", YouTube, Available at: https://www.youtube.com/watch?v=f_t8d18TZ0Q

HortSMART, 16/9/2015, "Yield mapping and monitoring of Queensland vegetable crops", YouTube, Available at: https://www.youtube.com/watch?v=zCA1vFk9Ri0

HortSMART, 07/09/2015, "Using technology to identify crop variability in vegetables", YouTube, Available: https://www.youtube.com/watch?v=q1GUN1IOD9o

### Do you record nutrient applications?

An accurate record of all fertiliser and soil additive applications should be maintained, including foliar application and fertigation. This applies both to organic (e.g. sheep, cattle, chicken manure) and inorganic fertilisers (e.g. superphosphate). Fertiliser application records are essential for nutrient budgeting.

Records of all fertiliser and soil additive applications must include: application date; location and crop; product used; rate of application; wind speed and direction; method of application/incorporation; name and signature of the person applying the fertiliser and soil additives. Hydroponic nutrient solution monitoring records should also be kept, with waste and drainage solutions managed to minimise the risk of environmental harm. A record of hydroponic nutrient solution monitoring must include: monitoring date; location and crop; pH and EC of feed solution; pH and EC of drainage solution; quantity of drainage solution; name and signature of the person conducting the monitoring activity.

Resource:

Refer to Hort360 Reef Certification Forms / Templates for guidance on required record information relating to nutrient application:

- Fertilisers and soil additives application record and;
- Hydroponic nutrient solution monitoring record

https://www.hort360.com.au/wordpress/wp-content/uploads/2019/11/Farm-Flow-Fertiliser-Use-Efficiency.pdf

### Is fertiliser application equipment (includes fertigation) properly & regularly calibrated & maintained?

Ensure fertiliser equipment is calibrated & maintained seasonally AND after any changes to application equipment. This could be at specific production blocks and will include irrigation application systems (Uniformity of injection systems and application uniformity of irrigation system). Most manufacturers supply information about how to calibrate equipment.

Note: Calibration must be carried out under normal operating conditions (speed, gear, engine load), with the implement in the ground, to avoid variations in wheel slip.

Fertilizers are corrosive: Clean bins, augers and applicators after use and oil where recommended. Most fertilizers are corrosive to steel. Ammonium nitrate and muriate of potash are corrosive to brass. Many factors influence how corrosive a fertilizer is, e.g.; its pH, presence of free acids, and whether it is an ionic compound, and if so, the ions it forms; its hygroscopicity, or tendency to absorb moisture. Additives and coatings are added to fertilizer to reduce its hygroscopicity.

Nutrient application equipment must be calibrated so that nutrient application rates and placement can be controlled. Maintenance of equipment to keep it in good working order such as cleaning, oiling and replacing worn parts will ensure that its performance can be predicted.

Calibration and maintenance of equipment will ensure that nutrient applications are carried out as intended in a nutrient management plan.

Most manufacturers supply information about how to calibrate equipment. If more accurate calibration is required, this can be achieved by one of the following methods:

Method 1: Measure the distance covered (D) in metres to apply a known quantity (Q) in kg of fertilizer (e.g. 50 kg).

Method 2: Remove the delivery hoses from the application tynes and collect and weigh the fertilizer in kg (Q) applied over a measured distance (D) in metres (e.g. 50 metres).

The application rate in kg/ha, for either method, can then be calculated as follows

Application Rate (kg/ha) =10 000 x Q (kg) D (m) x W (m)

where W = width of the applicator in metres.

For row crop planters, W is the (number of rows) x (row spacing).

Where it is necessary to change the setting on cog or chain drives, the following cog size calculations can be used:

Wheel Cogs:

$$\text{Number of teeth required} = \frac{\text{Required Rate (kg) x Present Number of Teeth}}{\text{Present Rate (kg)}}$$

Outboard Cogs:

$$\text{Number of teeth required} = \frac{\text{Present Rate (kg) x Present Number of Teeth}}{\text{Required Rate (kg)}}$$

*NOTE: Calibration must be carried out under normal operating conditions (speed, gear, engine load), with the implement in the ground, to avoid variations in wheel slip.*

Calibration of a fertigation system involves measuring time taken for the dye to travel from the fertigation unit to the first emitter in the block and then the last emitter in the block. This time measurement can be conducted using dye and or a fertiliser with test strip detection. Using dye is simple and easy to see when it appears in the block. Generally we would suggest using a red / pink colour at a rate of about 2litres of dye per 200-300litres of water depending on water quality. As long as the water in the fertigation tank is bright red / pink it should appear within the block.

Resource:

https://www.hort360.com.au/wordpress/uploads/Nutrient/Decision/Cracking%20the%20Nutrient%20Code%20optimized.pdf – refer to page 32

https://www.hort360.com.au/wordpress/uploads/Nutrient/Application/Fertigation%20System%20Performance.pdf

Refer to Hort360 Reef Certification Forms

- Calibration Record (Fertiliser)

# Sediment Management

Does farm run-off flow across vegetated buffers (or through buffer device) of sufficient width, type and quality before reaching a waterway or wetland?

The width of a buffer strip is measured perpendicular to the stream. The chosen width will reflect the intensity of source, the topography, and whether the buffer is to protect streams from groundwater or surface water sources. The minimum width for a well vegetated buffer (80% cover) to manage run-off is 5 m.

For the purposes of filtering out sediment and nutrients, aim for a buffer width of at least 10 m for a forest buffer on low gradient land, and 5 m for a dense grass buffer on steeper riparian land. Wider buffers are only necessary if there is an extremely intense source of sediment, such as might occur in the wet tropics where surface erosion rates are greatest. Where possible, however, it is more efficient to reduce the intensity of the source.

Where overland flow is funneled into narrow (less than 3 m) streamlines several centimetres deep, it is not possible to trap large quantities of sediment, particularly fine sediment, using grass filter strips. In these situations, a grass waterway needs to continue up the hill slope hollow for a width of at least 10 m so that overland flow hits the grass before it is confined, and deposits sediment at the edge of the waterway.

Sediment traps are generally not effective at removing fine particles or dissolved pollutants. Without a final filter stage these particles will continue through the system at each rainfall event.

Buffer strips work by allowing shallow dispersed flow to move through the vegetation, which then traps the sediments and particulate matter.

The flow into buffer strips needs to be dispersed and needs to remain that way as the water moves through the strip. Vegetation cover in the buffer strip needs to be similar in structure and must be maintained. The formation of concentrated flow channels should be avoided.

Where buffer strips are immediately adjacent to crop areas, the buffer can be slashed to manage pests.

Vegetation within buffer strips slows the speed of run-off, allowing sediments to be deposited into the buffer strip area.

Infiltration of water into the buffer strip also assists with the removal of other pollutants; however, buffer strips are less effective at removing dissolved nutrients and pesticides. Buffer strips perform best when there is dense vegetation growth at the ground level, e.g. vegetation with multiple stems and groundcover, and shallow flow depths (below the vegetation height).

Buffer strips need to be well vegetated. The most suitable species are grasses, sedges and rushes. Grass seeds can be used or naturally occurring grasses and groundcovers can be encouraged to germinate in the buffer area.

Use local guidelines if they are available to assist with plant selection or contact your local Landcare or Natural Resource Management group. Naturally vegetated systems such as waterways, wetlands and riparian zones are a good reference from which to create a species template.

The dry season is the best time to establish a buffer strip to reduce the risk of run-off induced erosion. It allows for adequate establishment and root growth before heavy summer rainfall. Planting early in the dry season would take advantage of the existing moisture in the soil. Irrigation and weed management may be needed until the vegetation is fully established.

Buffer strips rely on good, dense, similarly structured vegetation for optimal treatment. Adequate vegetation growth is the key maintenance objective for buffer strips while minimising channelisation.

The most intensive period of maintenance is during the plant establishment period when watering and replanting/reseeding may be required to ensure design densities of plants are achieved.

Typical maintenance will involve:

- Buffer vegetation being slashed to 300mm to maintain good cover and growth. Where buffers are immediately adjacent to crop areas the buffer can be slashed to 100mm to manage pests. The slashed material should be removed from the area and used on the farm.

- Weed management to prevent propagation of weeds downstream or in riparian zones.
- Replanting/reseeding of desired species to achieve design densities.
- Irrigating vegetation, as required.
- Removing sediment if its build-up is concentrated and impedes even flows through the buffer area. This should be done during the dry season to allow reestablishment of vegetation before the next wet season. Removed sediment should be disposed of in the farm blocks, away from the buffer and any other drainage lines.
- Filling any areas in the buffer that have been caused by erosion which are channeling flows.
- Six monthly inspections and or after major rainfall events

*Information in this fact sheet has been obtained from the following resources and is gratefully acknowledged.*

- *Buffer Strips fact sheet developed by QDAFF & Healthy Waterways with funding from Queensland Wetlands Program*
    - *Riparian Land Management Technical Guidelines. Volume Two: On-ground Management Tools and Techniques, Published by Land and Water Resources Research and Development Corporation (LWRRDC)*

Resources:

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Buffer%20Riparian/Sediment%20-%20Vegetated%20buffer-filter%20strips.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Buffer%20Riparian/Buffer%20Strip%20Factsheet.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Buffer%20Riparian/Designing%20filters%20strips%20to%20trap%20sediment%20and%20attached%20nutrient.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Soil%20Conservation%20in%20Horticulture.pdf

Do you have structures that collect sediment which are of sufficient size, design and are maintained efficiently?

Sediment traps or ponds (also called silt traps or ponds/sediment retention basins) aim to hold run-off water long enough to allow soil particles to settle. They can be small ponds or weirs, or large dams that capture and re-use run-off water.

Artificially constructed wetland systems may be established to capture sediment and remove the nutrient in run-off waters.

The size of sediment basins combined with the area to be treated will determine the level of treatment performance. Ideally sediment basins should be sized to only capture coarse to medium sized sediments. These sediments typically have low concentrations of attached pollutants e.g. nutrients, pesticides and metals when compared to finer sediments. This means the sediment captured has low levels of contamination which makes its removal and disposal simpler.

Treatment Process: Very fine particles are not typically captured in sediment basins because the hydraulics of the pond does not allow a long enough settling period. If conditions allow fine pollutants to be trapped, these may retain or adsorb pollutants which are susceptible to release under conditions of low redox potential caused by high organic loading and stratification (low oxygen supply to sediments) or when scouring occurs under high flow conditions or following dry periods. There may be some biological uptake of soluble nutrients predominantly by planktonic algae which can occur in the water column. However these pollutants are susceptible to being transported downstream during the next run-off event.

Passive treatment measures that incorporate sediment traps and artificial wetlands are increasingly being used to treat water leaving intensive horticultural properties. Runoff water can contain a mix of sediment, nutrients and chemical residues that can be damaging to the environment. A sediment trap is often the first stage of passive treatment after the other measures described above have been implemented. A sediment trap is a basin that removes heavy sediment and litter from runoff water by allowing it to settle out and be left behind when the water moves on. A sediment trap needs to be designed to allow easy access, so that the trapped material can be removed for disposal after it has settled out. Intensive farming systems that often have a high use of phosphate fertilisers can have high levels of phosphates attached to sediments in runoff water. Some of this phosphorus can be removed by capturing the sediment in a modified phosphate filter trap that incorporates lime-enriched sand. To remove fine sediments, dissolved nutrients and chemicals, runoff water leaving a sediment trap should be passed through a series of filter beds and constructed treatment wetlands. Physical and biological processes remove these contaminants progressively before it is released to the environment or reused.

Sediment basins are run-off treatment systems that promote the settling of sediments through the reduction of flow velocities (speeds) and their temporary detention. They target the removal of coarse and medium sized sediments from farm run-off. Key elements of the basins include inlet and outlet structures, settling pond and high flow and overflow structures. They can take various forms and can be used as permanent systems or temporary measures to control sediment loss during tillage and harvesting periods.

The following information, as per the Water Regulation 2016 legislation, sets out the permissible development per plan area within the Great Barrier Reef Lagoon catchment for the capture of overland flow.

Water Regulation 2016

Reprint current from 29 November 2019 to date (accessed 12 December 2019 at 10:42)

https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2016-0216#sch.9-pt.1

The *Water Act 2000* and associated water plans that manage overland flow do not specify the volume of contaminated agricultural run-off (CAR) that may be taken. Schedule 9 Part 1 of the Water Regulation 2016 within column 2 defines the limited capacity works for each respective water plan area mentioned in column 1, which is considered to be accepted development if relevant requirements complied with.

As per section 99(2) of the Water Regulation 2016, to be categorised as accepted development, operational works involving the take of overland water with limited capacity works must comply with the requirements applying to the work mentioned the Code for self-assessable development for taking overland flow water using limited capacity works. The owner of the land on which the works are constructed or a construction authority (if the works were constructed by a constructing authority) must notify the department of the location and capacity of works constructed under this code within 60 business days by copy of the form Notification of existing overland flow works.

An overland flow storage with a greater capacity than outlined in the Schedule 9 Part 1 of the Water Regulation 2016 or if the code is not complied with, is considered to be assessable development and requires a development permit.

The Water Plan (Wet Tropics) 2013 and the Water Plan (Barron) 2002 do not regulate the take or interference with overland flow (OLF).

The Water Plan (Burdekin Basin) 2007 regulates overland flow under section 79 and the Water Plan (Cape York) 2019 regulates overland flow under section 28. With regards to contaminated agricultural run-off, both plans refer to section 101(3) of the *Water Act 2000*. Section 101(3) of the Act states that a person cannot be prevented from taking overland flow water, that is contaminated agricultural run-off, to the extent the taking is necessary to comply with an obligation on the person under the *Environmental Protection Act 1994*.

If there is no water plan for your area:

e.g. Townsville coastal area south of Wet Tropics Water Planning area and to the north of the Burdekin Water Planning area.

As per the State Development Assessment Provisions (SDAP) for taking or interfering with water contained within the SDAP 2.5 code response template: State code 10 – Taking or interfering with water, which commenced 1 July 2019, as per Performance Outcome 8 (PO8):

- if the works taking contaminated agricultural run-off are less than 12 megalitres (ML) then the works are accepted development
- if the works taking contaminated agricultural run-off are greater than 12 megalitres (ML) then the works are assessable development and will require a development application

## Part 1 Works for taking overland flow water

| Column 1 | Column 2 | Column 3 |
|---|---|---|
| Area | **Works that are accepted development if relevant requirements complied with** | **Works that are not assessable development** |
| *Water Plan (Baffle Creek Basin) 2010* plan area | Works for stock or domestic purposes<br>Works of a capacity of not more than 20ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of either of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 52(1) of that plan;<br>(b) works constructed under a development permit |
| *Water Plan (Burdekin Basin) 2007* plan area | Works for stock or domestic purposes<br>Works of a capacity of not more than 250ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of either of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 80(1) of that plan;<br>(b) works constructed under a development permit |
| Coastal Burnett overland flow area under the *Water Plan (Burnett Basin) 2014* | Works for stock or domestic purposes<br>Works of a capacity of not more than 20ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 91(2)(g) of that plan;<br>(b) works constructed under a development permit |
| *Water Plan (Calliope River Basin) 2006* plan area | Works for stock or domestic purposes<br>Works of a capacity of not more than 5ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of either of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 15(1) of that plan;<br>(b) works constructed under a development permit |
| *Water Plan (Cape York) 2019* plan area | Works for stock or domestic purposes<br>Works to take overland flow water with a capacity of not more than 50ML situated in a catchment, other than the Normanby catchment, mentioned in schedule 2 of that plan<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of any of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 28(c) and (d) of that plan;<br>(b) works constructed for the taking of, or interfering with, water under section 97 of the Act;<br>(c) works constructed under a development permit |

| | | |
|---|---|---|
| | Works of a capacity of not more than 5ML situated in the Normanby catchment for taking water under section 99(2) of the Act | |
| *Water Plan (Fitzroy Basin) 2011* plan area | Works for stock or domestic purposes<br>Works downstream of the Fitzroy Barrage of a capacity of not more than 5ML<br>Other works of a capacity of not more than 50ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of either of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 111 of that plan;<br>(b) works constructed under a development permit |
| *Water Plan (Gulf) 2007* plan area | Works for stock or domestic purposes<br>Works of a capacity of not more than 250ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of either of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 79 of that plan;<br>(b) works constructed under a development permit |
| *Water Resource (Whitsunday) Plan 2010* plan area | Works for stock or domestic purposes<br>Works of a capacity of not more than 20ML<br>Works constructed to satisfy the requirements of—<br>(a) an environmental authority; or<br>(b) a development permit for carrying out an environmentally relevant activity | Repair or maintenance of either of the following works if the repair or maintenance does not alter the design of the works—<br>(a) existing works mentioned in section 68 of that plan;<br>(b) works constructed under a development permit |

Resources:

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Soil%20Conservation%20in%20Horticulture.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Farm%20Runoff/Sediment%20basins%20factsheet.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Control%20Measures/Farm%20run-off%20treatment%20systems%20toolkit.pdf

How do you ensure that soil is protected during non-productive cropping periods (plant bed management)?

Frequent 'clean' cultivation exposes soil to erosion, destroys soil structure and results in the loss of soil moisture Soil cover protects the soil from erosion by reducing the displacement (movement) of soil particles caused by rain or overhead irrigation droplets, and by slowing the movement of water across the site.

Types of soil cover include:

- Green manure/cover crops planted between (in space and time) commercial crops;
- Organic mulches, plastic, slashed inter-row material or crop residues spread over the exposed soil; and
- Products such as polyacrylamide (PAM), polyvinyl acetate (PVA) or molasses which bind soil together.

Control measures may include:

- avoiding soil tillage (where possible) during times of the year when heavy rainfall events are likely, especially in tropical areas
- avoiding cultivation of light sandy soils subject to regular flooding
- using minimum tillage systems that minimise mechanical disturbance of the soil
- using permanent bed systems that improve soil structure and soil stability through maintaining or improving soil organic matter levels
- planting green manure or cover crops during the period between commercial crops to cover the soil and increase soil organic matter levels for improved soil structure, stability and fertility
- under sowing or planting in the inter-row area at the same time as commercial crops
- leaving crop residues (where possible) on site until the area is next required
- minimising the time soil is left exposed between harvest and planting of the next crop; and
- establishing permanent grass or vegetation cover on areas that are not cropped

During the period between successive horticultural crops green manure crops or cover crops can provide the following benefits:

- protect the soil from erosion
- produce organic matter
- maintain soil biology
- add nitrogen (if they are legumes)
- break disease cycles
- compete against weeds

The following table shows how irrigation methods can be chosen based on slope

| Slope | Method | Comment |
|---|---|---|
| Level (< 1%) | All irrigation methods furrow irrigation most common | Furrow irrigation can be the most economical—for best results, land levelling and careful design of water distribution and drainage systems are necessary |
| Low slopes (1–3%) | All irrigation methods; carefully controlled furrow irrigation | Suited to low-pressure, centre-pivot, and lateral-move irrigators, as well as medium and high pressure systems, provided precipitation rates are not excessive. May be suited to well-designed furrow systems on permanent cover crops, but attention should be given to in-flow rates, run length and close monitoring. |
| Moderate slopes (3-15%) | Spray irrigation; travelling irrigators; micro-irrigation | Suited to low and medium pressure systems with low precipitation rates. In cultivated areas, soil stubble cover is required and contour banks should be used to prevent erosion. |
| Slopes > 15% | Spray and micro-irrigation | Soil stubble cover and contour banks are essential to protect soil from erosion. |

Resources:

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Fact%20Sheet_Managing%20Soil%20Erosion%20in%20Vegetatables.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Sediment%20-%20Fallow%20management.pdf

To reduce in-field losses your inter-rows are?

The runoff resulting from storm rainfall is a principal cause of erosion in cropping systems. Without adequate ground cover water flow across bare ground can be significant and will impact on run-off potential. Soil erosion results in the loss of productivity of our agricultural lands, causes sedimentation in downstream areas and has a negative effect on water quality. Adequate levels of surface cover play an important role in erosion control by avoiding the effects of raindrops falling on bare soils. Surface cover also encourages run-off to spread rather than to concentrate. However there is a natural tendency for run-off to concentrate as it moves down-slope. Groundcover is any material that protects the soil.

Reduce the potential of water to cause erosion by:

- Stopping external water flowing onto and through your paddocks
- Removing water safely from paddocks
- Reducing water speed flowing across the land
- Creating stable seedbeds that resist erosion
- Maintaining a protective ground cover

Examples of good practices

- Growing a mulch crop in the inter row after laying plastic mulch
    - This can be sprayed out prior to going to seed and form a dead mulch layer
- Growing a green manure crop between vegetable cropping cycles
    - Will provide soil cover and add organic matter to improve soil health.
- Growing a permanent mulch cover and never cultivate.
    - Sow crops through the mulch layer with appropriate machinery

The most efficient groundcovers for large land areas are living plants because

- foliage reduces the impact of raindrops
- foliage and stems reduce the speed of overland flow
- roots bind the soil
- soil organisms feeding on dead vegetation produce gums that aggregate soil particles, making them less erodible

Beds are usually formed just before planting the annual crop and are then covered with plastic mulch however, if they are formed some time before the crop is to be planted, both the beds and the inter-rows can be planted with a cover crop to protect against erosion. If necessary, this cover crop can later be removed—by spraying out with herbicide, by cultivation or slashing—before sowing or planting the horticultural crop.

Crops grown in beds with drip (or trickle) irrigation systems—tomatoes, melons, capsicums, zucchini, strawberries, for example—often use polyethylene plastic mulch as ground cover. The plastic mulch helps to reduce the requirement for water and fertiliser, suppress weeds, reduce disease, increase yields and improve fruit quality. The plastic will also protect the soil in the bed from erosion caused by raindrop impact. The mulch is laid out over the formed beds and seedlings or seeds are planted directly through holes made in the plastic.

However, the plastic mulch will concentrate runoff to the drains between the beds and this increased runoff may lead to scouring. It may also, potentially, persist in the environment long after its use. Biodegradable polyethylene mulches have been trialled to overcome these problems. The best biodegradable mulches (often starch based) have a known use-life and are broken down by soil bacteria and by exposure to sunlight as the crop matures. This technology has been used commercially in tomato crops in the Bowen district in recent years.

Pineapples are commonly planted into beds. At the completion of a pineapple harvest, large amounts of trash (200–300 tonnes/ha) may be left on the soil surface. Retaining this trash on the ground will reduce soil erosion, improve soil health and increase crop yields. The trash provides food for soil organisms and plant nutrients and may reduce the amount of fertiliser required by the next crop rotation.

On areas that are steeper than 3%, or in areas historically prone to erosion, pineapple growers are increasingly using inter-row cover crops. Where cover crops are not used in the drains between beds, mulch from a previous pineapple crop can be spread in these areas to provide cover over the lower sections.

Pineapple plants can also be established, in 'clusters' at regular intervals (5 m) across a drain or walkway, to slow the water running down the drains and to trap soil.

There are three important principles to consider in the control of erosion:

- Land should be used in accordance with its capability
- The surface of the soil needs to be protected by surface cover involving stubble management practices on cropping land and careful stocking strategies on grazing land
- Run-off needs to be controlled before it develops into an erosive force.

Plants protect the soil by providing canopy cover (more than 5 cm above the soil surface) and contact cover (up to 5 cm above the soil surface).

Canopy and contact cover both protect the soil against raindrop impact. However, contact cover is more effective in protecting soils because it slows runoff so that water infiltrates the soil and deposits any dislodged sediment around the plants. Good contact cover is crucial on sloping country.

A complete and permanent cover will usually reduce erosion to a negligible level. Any activity that disrupts vegetation cover on the land usually results in accelerated erosion rates. On cultivated soils, the nature of the canopy, the proportion and time of the year that the soil is covered and the amount and nature of residues left on the soil between crops are all significant.

Groundcover is a good indicator of farm productivity and sustainability. Without it, up to 85% of rainfall from storms can run off into creeks and streams rather than soak into the soil and be available for plant growth. When groundcover is thin, patches of bare soil provide a path for runoff to build up speed and erode the soil.

Estimates of minimum groundcover (%) required to reduce erosion for a range of slope gradients and soil erodibility classes and soil types.

| Erodibility | Typical soil types | Flat | Gentle | Moderate | Steep |
|---|---|---|---|---|---|
| Low | Deep sands | 60 | 80 | 90 | 100 |
| Low to moderate | Sandy loams, Light clays, Ferrosols | 60 | 85 | 95 | 100 |
| Moderate to high | Dermosols, Vertosols | 65 | 90 | 100 | 100 |
| High | Kandosols, Sodosols | 70 | 90 | 100 | 100 |
| Low to high | Drainage lines (all soil types) | 100 | 100 | 100 | 100 |

*Source: NSW DPI Agfact P2.1.14 January 2005. Maintaining groundcover to reduce erosion and sustain production.*

There are design features and practices that affect the velocity of flow in drains between beds:

| Feature of drains between beds | Practices that affect velocity of flow in drains between beds |
|---|---|
| Gradient | Beds can either be aligned to the contour, across the slope or up and down the slope.<br>Gradients are required that provide adequate drainage but not excessive velocities which lead to erosion. To avoid water ponding and poor drainage, a minimum grade of 1% is normally used for the bed direction. |
| Depth of flow | Flow depth has a significant effect on velocity. On steeper gradients, velocities and the rate of discharge increase dramatically as run-off rates and the depth of flow increases. Run-off rates depend on the width of beds, cropping practices and row length. Plastic in the beds would increase the rate of runoff. |
| Shape | The wider the drain, the greater the capacity and the less potential for erosion to occur. A flat base (trapezoidal, parabolic or 'U' shaped) in the drain between the beds is preferred to a V-shape. Flat bases make better walkways and have lower runoff velocities for better erosion control. The shape of a drain profile can change after a series of rainfall and runoff events. This is especially so in crops such as pineapples which have a crop cycle of three to five years. |
| Length | As row length increases, the depth of flow and rates of erosion are likely to increase. Row length can be reduced by modifying the bed design, by using contour banks or by installing cross drains or interceptor drains after the crop has been planted.<br><br>Row length also affects the efficiency of farming operations. Long rows have advantages, but if a crop is harvested by hand, using buckets, the length of row needs to be taken into account so that full buckets do not have to be carried a large distance.<br><br>The ends of furrows/walkways must drain freely and should not be blocked by the presence of raised roads, rills from recent road grading or the accumulation of silt. |
| Presence of vegetation or mulch | On a smoothly tilled, bare soil, velocities can become erosive once they exceed 0.5 m/sec. However a cover crop in the drain greatly reduces flow velocities and provides protection from erosion. |

| | |
|---|---|
| Soil tilth | A compacted drain can tolerate higher velocities and has more resistance to erosion. Soil strength can be increased by compaction of the drain with a rubber tyred vehicle. |

Information in this fact sheet has been obtained from the following resource and is gratefully acknowledged.
Draft Chapter 14 Soil Conservation in Horticulture, Bruce Carey, retired Soil Conservation Officer DSITIA

Without mounds, erosion can occur when runoff from the bare land under trees is diverted by the strip of grass between the trees. This occurs because erosion of soil in the tree row makes it lower than the grassed, inter-row area. This process is referred to as a 'gutter effect'. It is less likely to occur if the rows are on the contour, but can be a significant problem if the rows are diagonal to the land slope. This problem can also occur between mounds if there is excessive grass growth or insufficient grass width between mounds.

Rows of permanent tree and vine crops such as bananas, papaws, macadamia nuts, avocados, citrus and grapes are often planted on top of mounds.

Mounds are constructed using topsoil excavated from the inter-row area. This provides a good depth of well-drained soil for the crop. The area between the mounds acts as a drain to provide good surface drainage and to manage run off for erosion control on sloping land. The drains flow to an outlet such as a natural drainage line, a subsurface waterway, or an in-field diversion bank. A disadvantage of mounds is that they expose a greater surface area of soil which results in a greater loss of soil moisture by evaporation. It is especially important not to expose dispersive subsoils in the drain.

Mounds can either be aligned to the contour with a small gradient to conduct runoff or they can have steeper gradients and be either at some diagonal to the slope or directly up and down the slope. Where mounds are not aligned to the contour, the inter-mound area needs to be grassed to prevent erosion. As the trees grow and the inter-row area becomes shaded, it can become difficult to maintain a good sward of grass in the inter-mound area.

The following table compares the relative advantages of mounds aligned to the contour compared to mounds diagonal to or directly up and down the slope. As a general guide, 5 to 8% is considered to be the maximum slope for mounds aligned to the contour and 15% for up-and-down slope mounds.

For crops that require maximum sunlight down the rows to encourage flowering and fruiting, it may be necessary to have straight rows in a north-south direction. This would usually necessitate the use of cross- slope mounds rather than mounds aligned to the contour.

| Relevant issues for comparing 'across-slope' and 'up-and-down hill' mounds | | |
|---|---|---|
| Issue | Mounds aligned to the contour | Mounds diagonal to the slope or directly up and down hill |
| Topography and land slopes | Mounds on steep slopes can hold much less water than mounds of the same height on lower slopes.<br><br>The steeper the slope, the more difficult it is to build high mounds with broad batters. Row width will be regulated by the slope rather than the best row spacing for the crop. | It is easier to build mounds on steeper slopes because less height is required to accommodate run-off. |
| Soil depth | Less suitable for shallow soils on steeper slopes as subsoils will be exposed in the drain | Can be constructed on reasonably shallow soils on steeper slopes |
| Traffic-ability | Wheeled equipment pulled on the contour across steep hillsides, tends to slip downhill and may cause damage to plants and hanging fruit (e.g. bananas)<br><br>A flat bottomed channel between mounds becomes less feasible as land slope increases. | On steep slopes, traction may be an issue in wet weather and a greater amount of horsepower is required.<br><br>A flat-bottomed channel is easy to achieve especially when mounds are directly up and down hill |
| Capacity to carry run-off | Effective capacity for a given mound height reduces as slope increases. | Provided any 'outside' run-off has been diverted, up-and-down hill mounds should carry all of the run-off they are required to, irrespective of mound height. |

| | | |
|---|---|---|
| Use of rainfall | More rainfall soaks into the soil | Higher rates of run-off than when mounds are on the contour. Grass in the drain between mounds may compete with the crop for moisture |
| Erosion | Minimal erosion if low gradients are used or channels are grassed | Good cover levels are required in channels especially for gradients above 2%. |
| Channel roughness | Bare soil is acceptable on low gradients and provides minimal resistance to surface flow. | The grass between mounds should be slashed as high grass can resist flows and direct run-off onto the bare area under trees. |
| Drainage | Mounds provide good drainage but not as rapid as for drains up and down the slope. | Rapid drainage |
| Marking out | Layouts take longer to mark out because key rows need to be surveyed and gradients in parallel rows need to be checked periodically | Easier to mark out because gradients are less of an issue |
| Construction | Construction becomes very difficult and costly on steep slopes with batters become unacceptably steep and susceptible to erosion | Relatively straight forward<br><br>Easier to construct double rows |
| Harvesting | On steeper slopes accessibility can become difficult on the down-slope batter of a mound | Accessibility is easier than for mounds aligned to the contour |

Information in this fact sheet has been obtained from the following resource and is gratefully acknowledged.
Draft Chapter 14 Soil Conservation in Horticulture, Bruce Carey, retired Soil Conservation Officer DSITIA,

Resources:

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Sediment%20-%20Inter-row%20management.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Sediment%20-%20Row%20plantings%20on%20mound.pdf

### Are headlands / roads maintained to reduce run-off?

The degradation of headlands / roads limits access to paddocks and increases sediment movement onto productive areas. Ensure you incorporate headlands / roads into a farm maintenance plan, redesign as necessary and review program annually.

When located above and below blocks, permanently grassed headlands and buffers can reduce the speed of water flow and filter sediment out of run-off. You can manage permanent headlands and buffers by:

- Determining headland and buffer width based on slope. The steeper the slope, the wider the headland or buffer will need to be
- Locating headlands and buffers across the slope where water is concentrated, this includes around dams and adjacent to waterways. Buffers aren't as effective on slopes greater than 15%. Diversion banks should be used on steeper slopes
- Sowing headlands and buffers with perennial grasses that are maintained (slashed) to encourage deep rooting and dense and vigorous growth. A swathe height of 15 cm is recommended for maximum filtration capacity. Grasses should be selected based on their ability to handle traffic, as well as wet and dry spells
- Controlling broadleaf weeds in headlands and buffers using a selective herbicide
- Minimising traffic on headlands and buffers, particularly when wet

Resources:

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Farm%20Runoff/Sediment%20-%20Run-off%20from%20on%20farm%20roadways.pdf

https://www.hort360.com.au/wordpress/uploads/Run%20Off/Infield%20Runoff/Soil%20Conservation%20in%20Horticulture.pdf – refer to pages 10-12

# Pesticide Management

In an effort to reduce pesticide use on farm do you use any Integrated Pest Management (IPM) methods?

A well-developed IPM strategy includes all agricultural pests - diseases, weeds, invertebrates (such as insects and mites) and vertebrates (such as birds, mice and bats) thus becoming part of a fully integrated farm management system.

In practice growers fall in a range from 'Integrated Pesticide Management' to 'Bio intensive' IPM. IPM involves routine crop monitoring, appropriate timing of pesticide applications, attention to appropriate spray application technique and following pesticide resistance management strategies. A Bio intensive IPM strategy relies primarily on beneficial organisms to manage pests and when greater pest control is needed, interventions chosen are complementary to the preservation of Beneficial's.

However, as strategies are developed for the target pest, the focus moves to other key or minor pests, diseases and weeds.

Integrated Pest Management (IPM) involves a range of strategies:

- Training in recognition of the pests and diseases that can attack your particular crops, their symptoms of attack and life cycles.
- Regular monitoring of crops for pests, diseases and weeds.
- Only using pesticides if pest numbers exceed threshold levels, and consider using:
    - Environmentally friendly pesticides, such as oils, soaps and biological control agents such as bacillus formulations;
    - Narrow-spectrum pesticides instead of broad-spectrum pesticides;
    - Spot applications of pesticide instead of blanket sprays;
    - Strategic application when the pest or disease is most vulnerable; and
    - Resistance minimisation strategies
    - Practicing good hygiene to limit disease in particular
- Having an all-year-round weed management program in place, both in and around the growing area – weeds can harbor pests and diseases and act as a constant source of re-infestation (although weeds may also be a refuge for natural predators).
- Maintaining good soil health, including an open, well aerated structure, high organic matter levels and a diverse and active soil biology, which in turn promotes healthy crops which are more resistant to disease and pests.
- Encouraging natural predators.

Resources:

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Best-practice-IPM.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Management%20&%20Safety/Integrated%20Crop%20Management.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/IPM%20case%20study.pdf

Are you maintaining accurate spray diaries?

Records are an excellent management tool and provide an information source. Properly kept records of chemical applications are critical documentation to prove your chemical application practices. Most produce buyers and retailers now expect their suppliers to keep detailed spray records and will require evidence that you are doing so.

Records of all pre-harvest chemical applications are kept and must include:

- application date
- start and finish times
- location and crop

- chemical used (including batch number if available)
- rate of application and quantity applied
- equipment and/or method used to apply the chemical
- wind speed and direction
- withholding period (WHP) or earliest harvest date (EHD)
- method of disposal of leftover chemical solutions
- name and signature of the person who applied the chemical

This knowledge can them be used to assist the grower in developing their pest management program.

Resource:

Refer to Hort360 Reef Certification Forms

- Pesticide Application Record

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Spray_Application_Basics.PDF

### How do you determine crop / pest chemical requirements?

The traditional approach to spray application is to follow a calendar program. This involves scheduling sprays according to the number of days that have elapsed since the last spray or the casual sighting of above average numbers of insect pests. Program spraying can speed up for the rate of selection for insecticide resistance. Constant use of chemicals with the same mode of action will select from a population, the individuals which are resistance to the chemical being used frequently. Resistance can develop in non-target pests that are exposed repeatedly to the same MOA used for a number of key pests. Resistance can be slowed through;

- targeted insecticide application
- rotation of chemicals with different modes of action against the same pest
- using 'softer' insecticides to encourage beneficial insect predators and parasites

Integrated pest management (IPM) refers to using multiple techniques to prevent crop damage from pests. The term 'pest' includes insects, plant diseases, weeds, nematodes and other organisms including vertebrate pests such as flying foxes that cause economic damage to crop yields. Pest management in this context refers to the management of the impacts of the pest on the economic output of the farm.

Resources:

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Best-practice-IPM.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Management%20&%20Safety/Integrated%20Crop%20Management.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/IPM%20case%20study.pdf

Refer to Hort360 Reef Certification Forms

- Pest and Disease monitoring record
- Preventive pest and disease control program

### To reduce the loss of chemicals via spray drift you?

Spray drift is the movement of agricultural chemicals away from the target area during or after ground or aerial spraying (in the form of droplets, particles or vapour). Agricultural chemicals can drift long distances under certain weather conditions.

Spray drift or overspray can be a possible source of environmental contamination. One of the main causes of this may be from spraying chemicals in unsuitable weather conditions.

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is increasingly requiring chemical label directions to include relevant weather information to minimise the occurrence of spray drift for the protection of crops, natives and other non-target plants.

Ensure label information on the suitability of weather conditions required for use of each chemical is checked prior to chemical use. The visual wind speed indicators do not provide a complete assessment of the weather conditions affecting the likelihood of spray drift.

Other weather conditions impacting on the likelihood for spray drift include temperature, humidity, evaporation rate and inversion conditions. The use of weather monitoring devices should be used to provide more specific weather information including temperature, relative humidity, wind speed and direction.

Resources:

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Application%20and%20Drift%20Management%20BGordon%20presentation.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Spray%20Drift%20Best%20Practice%20Guidelines%20July11.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Spray_Application_Basics.PDF

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Spray%20Drift%20Management%20CSIRO.pdf

### Is chemical application equipment properly & regularly calibrated?

The objective to applying pesticides is to deliver the required amount of active constituent of the chemical to the target area. Regular calibration allows the operator to check that each component is operating within acceptable limits. It will also prevent over or under dosing of the target area, reduce environmental impacts and manage resistance.

Resource:

Refer to Hort360 Reef Certification Forms

- Calibration Record (Pesticide)

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/boom%20sprayers.pdf

https://www.hort360.com.au/wordpress/uploads/Pesticide/Application/Calibration%20%20Guide%202009.pdf

## Water Management

### Do you know the rate of water applied by your irrigation system (ie mm/hr or L/hr)?

Efficient and effective irrigation requires the ability to accurately apply a desired volume of water to the crop. This in turn requires an accurate knowledge of the rate of water application by the irrigation system. The level of accuracy required can normally only effectively be achieved through direct measurement of the discharge rates under operational conditions. While discharge may be nominally provided by suppliers and dealers, the use of inappropriate operating pressures, blockages, pipe and nozzle wear, as well as system maintenance and operating conditions may all affect the discharge for the system.

In general, to determine rate of application (mm/Hr) you require information relating to flow rate of emitter and wetted area covered ($m^2$).

For pressure compensated systems as long as the irrigation system is operating at required pressure (i.e. within the pressure band as specified by the manufacturer) the emitter should emit the flow rate as specified.

For centre pivots / lateral moves / traveling booms with Nelson / Senninger sprinklers and pressure regulators

- for the regulator to operate correctly the pressure above the regulator needs to be a minimum of 8psi higher than the regulator set pressure

Drip

- Overlapping wet area – this would look like a long wet sausage along length of drip
  - Emitter flow rate (l/min)
  - Emitter spacing along length (cm)
  - Distance between drip lines (m)
  - 60 x l/min / (emitter spacing x distance)
- example
  - 60 x 3 / (30 x 2) = 3 mm/hr

Micro-sprinkler

- flow rate of sprinkler (lph) / wetted diameter (m) x wetted diameter (m) x constant 0.785 = average application rate (mm/hr)
- example
  - flow rate 75 lph & wetted diameter 3m
    75 / (3x3) x 0.785 = 10.62 mm/hr

Solid Set

- flow rate of 1 sprinkler (lph) divided by sprinkler spacing x lateral spacing (m) = average application rate (mm/hr)
- example
  - sprinkler 75 lph, sprinkler spacing 6 m, lateral spacing 6 m
    75 / (6 x 6) = 2.08 mm/hr

Centre Pivot / Lateral Move / Traveling boom

- A calibrated control box will provide application rate as an output in mm OR
- Average Application Rate (AAR) = Nozzle flow rate (lph) / wetted area ($m^2$)
- example
  - Wetted Area is emitter wetted width x emitter spacing
    - 12m x 2 m = 24 $m^2$
  - Nozzle flow rate is 0.4 L/s x 3600 = 1440 lph
  - AAR is Nozzle flow rate (lph) / wetted area ($m^2$)
    - 1440 lph / 24 = 60 mm/hr

Resource:

Refer to Hort360 Reef Certification Forms

- Maintenance and Service – Irrigation application rate record

https://www.hort360.com.au/wordpress/uploads/Irrigation/Irrigation%20Management/Water%20Management.pdf

https://www.hort360.com.au/wordpress/uploads/Irrigation/Water%20Supply/Estimating-how-much-water-should-be-applied.pdf

### Do you have a procedure for determining when to irrigate and how much to apply?

Appropriate irrigation scheduling, based on timely measurements or estimations of soil moisture content and crop water needs, is one of the most important requirements for irrigation management. Scheduling involves the identification of both the appropriate time to irrigate as well as the appropriate volume of water to apply. A number of devices, techniques, and computer aides are available to assist producers in determining when water is needed and how much is required. Producers should choose the scheduling method which best suits their needs and management capabilities. Regardless of the method used, some on-site calibration and the appropriate location of the sensor in an area of the field which is representative of both the water application and the crop extraction is essential. Many producers find that irrigation services offered by crop consultants are the most cost-effective method of scheduling and managing their water.

Irrigation scheduling uses a selected water management strategy to prevent the under or over-application of water while maximising net return. In a sense, all irrigations are scheduled, whether by sophisticated computer controlled systems, water availability, or just the irrigator's hunch as to when water is needed. Experienced producers know how long it takes them to get water around their farm and are proficient in avoiding crop stress during periods of average rainfall. The difficulty lies in applying only enough water to fill the effective root zone without unnecessary deep percolation or runoff. Proper accounting for crop water use ensures optimal crop production quality and provides producers with the knowledge of how much water should be applied at any one irrigation event.

Subjective Tools: Finger, Shovel, Push Rod, weather data

Objective Tools: Tensiometers, Capacitance Probes, TDR Systems, on site weather station / evaporation pan

Resource:

https://www.hort360.com.au/?page_id=272 – go to Crop Water Use Efficiency Benchmarking fact sheets for crop water requirement information

Go to (insert link) to calculate crop water requirement

https://www.hort360.com.au/wordpress/uploads/Irrigation/Irrigation%20Management/Scheduling%20Tools.pdf

https://www.hort360.com.au/wordpress/uploads/Irrigation/Irrigation%20Management/Positioning%20of%20soil%20water%20monitoring%20tool.pdf

https://www.hort360.com.au/wordpress/wp-content/uploads/2019/12/Horticulture-manufacturers-factsheet.pdf