

Guidelines for irrigation management

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RMCG

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**Guidelines for Irrigation Management for the Apple
and Pear Industry**

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Final Report*

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Summary

RMCG was engaged by Horticulture Australia Limited (HAL) and Apple & Pear Australia Limited (APAL) to develop *Guidelines for Irrigation Management for the Apple and Pear Industry*.

The guidelines aim to facilitate the efficient management of water (including during water shortages).

The project was composed of four key tasks. Completion of these these tasks is summarised below.

Task	Progress
1. Review current information	<ul style="list-style-type: none"> ▪ A review of the national and international literature was undertaken with the development of a table of contents and key reference list.
2. Determine industry expectations	<ul style="list-style-type: none"> ▪ Industry expectations were identified through examining industry surveys, conducting meetings with the steering committee and obtaining feedback from presentations.
3. Prepare draft guidelines	<ul style="list-style-type: none"> ▪ Draft guidelines developed.
4. Prepare final guidelines	<ul style="list-style-type: none"> ▪ Feedback from the IAC and seven apple and pear growers has been obtained on the draft guidelines. This feedback has been incorporated into the document where appropriate; ▪ Final feedback from the Management Committee has been incorporated to finalise the guidelines.

1 Background

1.1 Issue

Water management is a key issue for apple and pear orchards.

Pressures on water availability for irrigated horticulture were highlighted at HAL Industry Forums with a specific focus on drought management. A facilitated workshop identified key issues that individual industries and the whole of horticulture need to address to contend with the current lack of water. Of particular relevance was the provision of information enabling growers to make better management decisions and extension of water research to all commodity groups.

The across industry Horticulture Water Initiative (HWI) provides a voice for the whole of the horticulture industry. The focus of HWI is 'ensuring access to water for responsible and profitable horticulture'. While the HWI provides the higher-level coordination of water issues for the Horticulture industry there is little scope to tailor programs/information for individual commodity groups. To facilitate a joint understanding of what the HWI can provide and the needs of the apple and pear industries a meeting was held with APAL and HAL (30th November 2006). This meeting highlighted some critical issues:

- All APAL members need to consider water is a valuable resource;
- The HWI can provide a voice for the whole of the industry – both regulated and unregulated systems as water is limited in all situations;
- Apple and pear orchardists need to adopt efficient water management as a matter of course (not only during drought).

1.2 Objective

The project objective was:

- To develop irrigation guidelines facilitating the efficient management of water (including during water shortages).

1.3 Outcome

This project was designed to collate and coordinate the packaging of existing information to enable growers to implement efficient irrigation management on their orchards. This was identified as an immediate need that can capitalise on the research and development work previously undertaken.

It was stated that the irrigation guidelines would be practical and useful to apple and pear growers across Australia. They would be based on what is considered "Good Practice" and management during "Water Shortages".

The apple and pear industry had clear expectations about the type of information required and how it could best be presented. Input from the industry was a critical component of the project.

2 Methodology

The approach used for developing the guidelines is described below.

Task 1. Review current information

Key information was compiled from national and international sources. This included an analysis of irrigation guidelines (applied information) and research findings.

Task 2. Determine industry expectations

A small management committee was established having ongoing input into the guidelines to ensure practicality, usefulness and presentation form.

Task 3. Prepare draft guidelines

Draft guidelines were developed including information on:

- Matching irrigation to soil types;
- Understanding rooting systems (root depth, rootstocks);
- Irrigation systems – pros and cons;
- Irrigation scheduling – soil moisture monitoring, plant responses;
- Water budgets; and
- How best to use a limited water supply.

Task 4. Prepare final guidelines

Following feedback from the management committee and additional leading growers the guidelines were modified and prepared to a print ready format. Final feedback from the management committee has been incorporated to finalise the guidelines.

3 Process for Development

3.1 Industry context

The underlying principles for the establishment of irrigation guidelines for the apple and pear industry were as follows:

- *Focus on water management;*
- *Responding to industry needs;*
- *Practical and easy to read;*
- *Based on best available technical information;*
- *Produced in a format that industry wants;*
- *Applicable to all industry regions;*
- *Integrates with information from FO2012; and*
- *Complimentary to extension structure in FO2012.*

The situation with water for the apple and pear industry can best be described as:

- *Water is generally not a high priority issue for orchard productivity;*
- *Risk management approach is generally to apply more water;*
- *In the last 10 years most regions have/are experiencing water scarcity;*
- *Horticulture Water Initiative provides high-level position/communication;*
- *Industry has heightened awareness of tree management through FO2012;*
- *Existing extension structure through FO2012; and*
- *Extensive amount of technical information available on irrigation management.*

The project was required to provide:

Information that the industry wants and can use in a format that is user friendly.

3.2 Review of literature

A review of the literature was undertaken with the development of a table of contents and an assessment of major gaps in research (Appendix 1). The literature review included national and international references (Appendix 2).

The key information developed focused on the following areas of irrigation management:

- Understanding critical growth stages

An understanding of the development of fruit and vegetative growth of apple and pear orchards is critical to ensure balance in vegetative vigour and maximum yields.

- Matching irrigation to soil type
Matching irrigation application rates to soil types will help producers minimise water wastage, prevent soil issues such as waterlogging and salinity and minimise off-site impacts.
- Understanding rooting systems (including root depth and rootstocks)
This will ensure that trees are best adapted to local orchard conditions ensuring improved health of trees and orchards better able to cope with drought conditions.
- Different irrigation systems including pros and cons
Understanding the pros and cons of different irrigation systems will enable producers to choose the most suitable system for their particular orchard.
- Irrigation scheduling (soil moisture monitoring, plant responses)
Identifying the latest scheduling techniques will provide growers with a series of tools to enable efficient irrigation in both drought and non-drought periods.
- Water budgets
Understanding how to develop a water budget for an orchard will provide growers with information so they can determine how much water they need over the season and where efficiencies may be made.
- How best to use a limited water supply
Strategies for managing apple and pear trees under drought conditions, including scheduling techniques, soil, nutrient and water management, will be identified. This will provide growers with an array of on-farm tools to help maintain tree health and will build on previous sections of the guidelines.

3.3 Industry engagement and feedback

A survey of 70 growers in the FO2012 project indicated that water management was a medium priority issue with understanding water requirements and irrigation scheduling important. The needs of the industry were explored during a meeting with the FO2012 steering committee and the Industry Advisory Committee (IAC) in June 2007. A summary of the draft contents of the guidelines was provided. Both committees agreed with the approach taken and areas of focus and provided useful comments that were incorporated into the guidelines.

Draft guidelines for irrigation management were developed based on the literature reviewed and the industry needs identified in previous tasks.

The draft guidelines were distributed to the IAC and seven growers to obtain feedback on the:

- Content – is the level of detail suitable; are there any major items missing; could some sections be reduced?
- Presentation - is there too much text and/or diagrams; is it readable; how could it be improved?

The views provided were considered and incorporated into the final draft guidelines where appropriate.

A diversity of views was provided through the grower feedback (detailed in Appendix 3). These views and their implications for the final draft of the guidelines are summarised below.

3.3.1 Level of detail

For those growers leading the industry in terms of innovative irrigation management, additional information to that currently provided in the draft guidelines was sought. This included extra detail based on the outcomes of research papers. However, these growers recognised that they were not 'average' growers and could understand why the draft guidelines did not provide additional technical detail.

At the other end of the spectrum, some growers felt the information provided in the draft guidelines was too technical and would not be understood by the majority of producers. They suggested the information be simplified.

Given the variation in grower knowledge and their information needs, it is important the guidelines be pitched at the right level to maximise its value – i.e. be useful to as many growers as possible. It is recognised that some growers will want to seek additional information.

3.3.2 Format

Feedback on the format of the draft guidelines was also variable. Some growers were happy with the layout, while others preferred a shorter and more succinct document that was tailored specifically to their region. As a result, there is an opportunity to print the guidelines in different formats to meet growers' needs.

3.3.3 Rolling out guidelines

Good ideas were provided on how the guidelines could be rolled out to growers. A common suggestion was incorporating the guidelines into existing programs where there is already grower participation and interest e.g. Future Orchards 2012 Program, Water for Profit in Queensland.

Most growers preferred having printed hard copies of the guidelines.

Another suggestion was developing a web-based tool that simplified the calculations and allowed the information to be tailored to the situation for individual growers. The majority of growers were positive about the value and usefulness of a web-based system, especially if combined with a hard copy of the guidelines. Due to the current interest in a web-based tool, we would like to further explore this concept with HAL.

3.3.4 Changes to draft

Following feedback from the management and additional leading growers the guidelines were modified and prepared to a print ready format.

4 Final approval

Final comments and approval were received from the IAC members in June 2008. The comments were all positive regarding the final document provided with the use of working examples being particularly helpful.

Some minor modifications were made to the document with the final version of the guidelines being provided (Appendix 4). This version has been provided in a pdf and Microsoft Publisher version.

Appendix 1: Gap Analysis

A review of the literature was undertaken to inform the development of the guidelines. This review also highlighted some of the deficiencies in our knowledge with respect to water management for apples and pears.

This assessment summarises the major gaps in our knowledge and indicates areas where resources could be invested in future. A list of papers reviewed is provided.

1. Optimisation of fruit yield and quality

Irrigation management has generally been focused on the assumption that more water will result in increased yields and quality. This of course assumes that excess amounts of water are not causing waterlogging. However, more recent research and anecdotal evidence suggests there is an optimal volume of water i.e. less water may in fact improve fruit quality while not compromising yield. What is the optimal volume and what are the key parameters that need to be considered?

- Interactions between irrigation and
 - Crop load;
 - Fruit size; and
 - Quality.
- Water requirements under various conditions at different stages of growth;
- Deficit irrigation.

Crop load, fruit size and quality are intimately linked. Determining the impact that irrigation has on these factors is important so that recommendations can be made on how to irrigate when aiming to achieve a certain objective eg fruit size. Understanding water requirements and the application of deficit irrigation is also an area of research. While there has been extensive research overseas (USA, Israel, NZ) this information needs to be tested under Australian conditions.

High priority

2. Rootstocks and varieties

- Drought tolerance
- Water requirements
- Irrigation management

There has been minimal effort in the breeding of drought tolerant rootstocks in apples and pears. Given climate change and the increasing difficulty in accessing water drought tolerance should be considered.

Understanding the differences in water requirements of rootstocks and varieties is critical to assist efficient irrigation management. This would need to consider rooting patterns, canopy architecture and other physiological attributes.

Medium priority

3. Nitrogen management and fertigation

- Nitrogen leaching
- Maximising uptake

The management of nitrogen is intertwined with irrigation management. Both nitrogen and water can be used to manipulate the tree to either grow vegetatively or fruitfully. This is a delicate balance and understanding the interactions between water and nitrogen and the impacts on fruit quality and yield is important.

Medium priority

4. Irrigation and root interactions

- Root volume
- Root restrictive layers

The amount of irrigation required is linked to the volume of roots of the tree. This volume has also been shown to impact on the size of the tree. In some instances restrictive materials have been used to limit the size of the root system and hence the size of the tree (similar to dwarfing rootstocks). Understanding this relationship may assist in the management of rootstocks but has minimal application.

Low Priority

5. Irrigation scheduling using plant based methods

One of the major areas of irrigation research is assessing different methods to determine plant water status. The premise behind this work is that the plant is the best indicator of whether its growth is limited by water stress. Currently we use secondary indicators to determine the plant water status i.e. soil water moisture and weather conditions. Research into stem shrinkage and leaf temperatures is not new however there have been recent quantum leaps with the technology used to measure these parameters. This work is significantly closer to practical application. There should be a watching brief.

Medium priority

6. Irrigation for evaporative cooling

There has been an area of into using irrigation for evaporative cooling. This may become a more significant issue in the future.

Low priority

Appendix 2: Literature Reviewed

Literature review includes resources that were used for development of guidelines and analysis of recent research undertaken to inform research priorities in irrigation management.

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Appendix 3: Grower Feedback

Introduction

As part of developing the *Guidelines for Irrigation Management for Apple and Pear Growers*, several growers were contacted (some visited) around October 2007 to obtain feedback on the draft guidelines.

The growers who provided feedback were:

Kevin Sanders	Michael Cunial
Ugo Tomasel	Daniel Nicoletti
Ron Gordon	Roger Lenne
Peter Hall	

Messages were left with three growers, but no response was received. This section summarises the feedback provided, which was incorporated into the final version.

Feedback on draft guidelines

Comments provided included:

Grower 1

- Quite good – not too long, if I planted new trees I would use the information within the guidelines to help me.

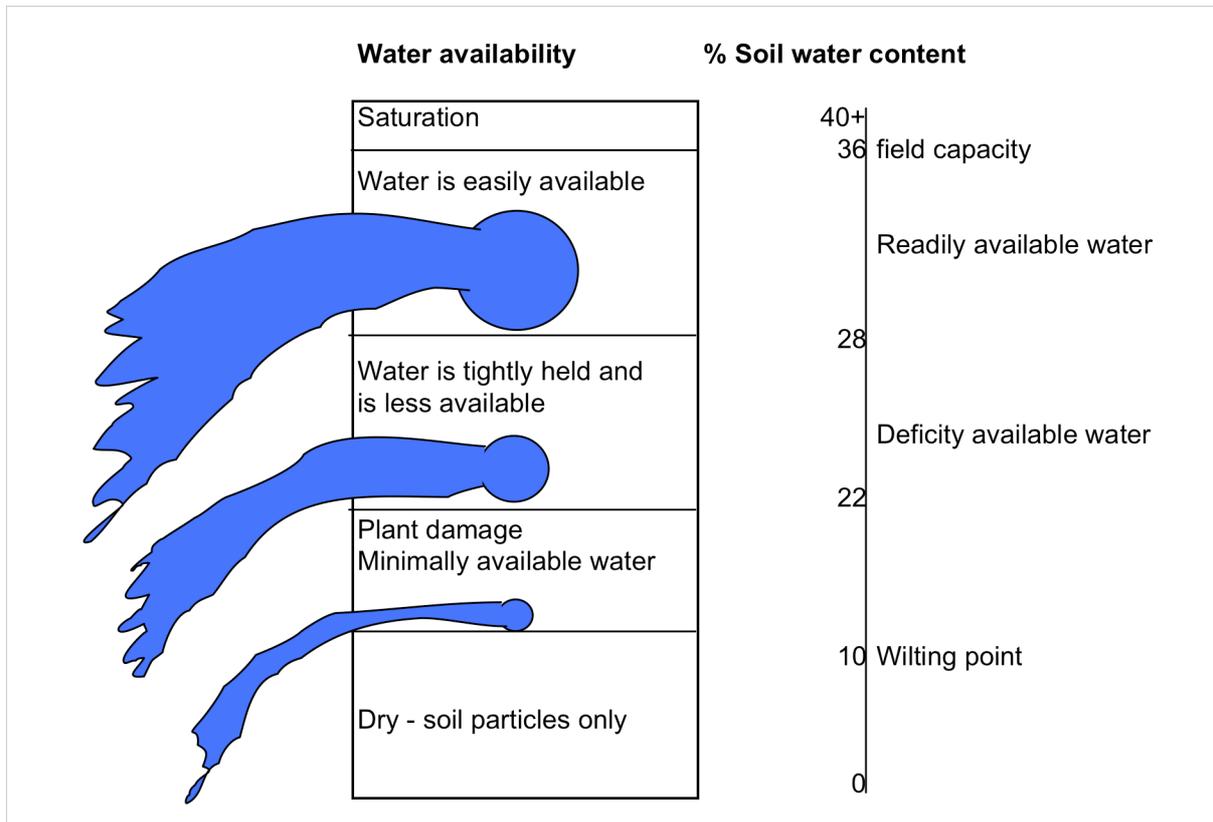
Grower 2

- Seems ok – information is relevant, maybe a little long, easy to see what is in each section.

Grower 3

- Need to write in a non-technical way – talk about for different irrigation systems, in an average week in this month, you would need to put out this many ML.
- Write the information in terms of how many hours you irrigate for – not as ML/ha.
- Question over Figure 3 – should it be disjointed in parts? Not a smooth curve?
- Figure 4 – too difficult to understand. Could portray in another way. E.g a jar with several holes of varying width that result in either more or less water being available. (see below for e.g)
- Don't use 'scheduling' but irrigation 'timing'.
- Need to explain water tension under section "Step 1" on page 9.
- Put in some average examples of soil moisture tension for different soil types (RAW) – can't dig soils pits for every block – unrealistic. Need to use averages.
- Example A: on page 10, say root depth of 2m by 2m for each tree. Say needs 144litres assuming? Rainfall? Totally dry soil?
- Convert ML/ha water requirement in column 1 of table 7 into a ratio based on January water requirement. E.g. 2/3 of irrigation need in January etc.

- Irrigation system choice – need to say that you have to take into account the soil characteristics.
- Say drip not suitable for sandy soils.
- Rather than all the tables, could have 20 concrete examples with real information growers can identify with. E.g. during RDI in October with a traditional spacing of x by x metres and 20 degrees temperature, assuming no rainfall, would need to put on what volume to replenish? (+/-20%).
- Say only have RDI if have monitoring equipment.
- If you have no equipment or consultant, use gypsum blocks as an entry point into soil moisture monitoring – cheap, easy to use, provides figures that science works on, no maintenance.
- Say need to see consultant to further advice.
- No time to do a budget – say from L in table, if half that volume then probably in trouble, if double that volume then overwatering.
- Give recommendations about RDI e.g. in November and half of December, water 1/3 of what you do normally (with soil monitoring equipment to keep check). Or aim for this kPa, so people can act.
- Think of in terms of red and green light – when and when not to act.



Grower 4

- Guidelines useful as a reference, but probably wouldn't use in an ongoing way.
- Need more information on deficit irrigation – what would be the water budget using deficit volume rather than survival only. What is the volume needed for different yields?
- Needs to be portrayed more positively – some sort of crop rather than none.
- Use standard discharge rate – L/hr/m of treeline.

- Information in table 1 needs better research – question over sprinkler application rate (more likely 75mm in 24 hrs), sprinkler cost alone is \$2,000, say installed and finished, what proportion of wetted area is covered?
- Need to make clear in tables that it is for tree survival only – extremes!

Grower 5

- Emphasis on water budgeting is too strong – difficult to do and few growers will do it.
- Should say that RDI is ok to use – makes out that it is not that suitable. Considerable amount of work on apples (South Africa, New York, Washington). If you can starve water prior to the end of shoot growth extension, you won't lose any fruit growth/yield.
- Few do scheduling – more of a gut feel.
- Aim of the guidelines should be to get across information on the best you could do with limited water – say when to apply to maximise production. E.g. period of flowering to end of shoot growth (cell division period), in winter zones usually have enough residual water in the soil to get through the season. We have had a serious drought but are still doing ok – neutron probe has said there is enough water in the soil.
- Growers should always use drip irrigation.
- Timing of irrigation is the most important information.
- Emphasis on yield is overdone. Most important things are size range for markets and colour. Bigger crop load – less colour. Importance of hail nets to avoid sunburn is not discussed.
- Need to remember that if you lose a little bit through poor irrigation, it can generally be made up elsewhere as lots of other factors to consider. E.g. sunburn is 2x more important than yield.
- Use of coefficients will be over most growers' heads – too scientific.
- Message needs to be sent visually and have instant meaning. E.g. fuel gauge ¼ full, then need more irrigation. This was part of existing approach used in work to show when to irrigate (fruit growth, volume is connected to water stress).
- Outline the critical times when water is important. If you lose some yield, small amount in the scheme of things. E.g. other factors like spring temperature are extremely important.
- Mentioning loss of dam water is really good – e.g. the water I lose from a dam (7/8ML /year from a 45ML dam) has more implications than the 5% loss of yield due to miss timing RDI – other important aspects of water waste exist.
- Water is currently too cheap for growers to change.
- Pulse irrigation is really good – I irrigate 4-5 times per day – maintains soil moisture potential. Can have 30-40% water saving through pulse irrigation and 30-40% saving through RDI.
- We have a perfect growth curve for apples.
- Change our version – says harvesting is based on colour and size. This should say harvesting is based on colour and maturity.

Grower 6

- Quite a good little document.
- Not sure about technical calculations – not my area of expertise. We use enviroscan and have logger that measures dry points.
- Not a scary document – easy read that gives advice.
- Take out reference to flood irrigation – shouldn't be relevant. Not good for industry to still be flood irrigating.
- Water budget good – growers in area are doing monitoring, but no doing budgets yet.
- Usually do a rough calculation for budget as limited water usually.
- DAW, RAW – bit difficult. Not sure how else you could explain it.

Grower 7

- Bit bland – already knew the information. Growers in that group are not average growers.
- Comments on other crops not relevant, unless relates some way to apples.
- Calculations are horrid – wrong. Total amount of water is ok, but how it should be applied is wrong e.g. 1st week in January can have 144 L, but not all at once.
- Didn't come across that it was for survival only.
- Dwarf trees need water in short periods, frequently. About same volume, but 3 times a day for 20 minutes. Mature tree may be watered for 1 hour a day. Depends on age of the tree. More likely to change irrigation when have new trees in and these need shorter watering periods.
- 30L/hour application rate is too high. More like 10L/hour. Semi-porous soil not suitable for this type of application rate.
- We measure water moving through the soil profile. Surprised more information on this is not in there. Will send a paper through on this.
- Simplify tables on water use – have best and worse and only show ¼ of season at a time. October to March/April is most important. Just have a normal and dry option for out of fruit growing stage.
- 26 pages is too long. Need to have condensed, short concise statements. 1-3 pages better. Could have tabs for different areas. E.g. for Batlow with heavy soils, go to this section. Growers won't spend ½ hour looking at it.

Rolling out guidelines

Comments from growers on how to best roll out the guidelines included:

- Level of apathy and fatigue from drought means growers are unlikely to be keen on a workshop, soil pit day etc.
- Need to have an interactive website – could enter inputs about your orchard and using weather information from elders site (for e.g) say this week need to apply what volume (estimates). Currently no information that is easily accessible for growers.
- Website would be useful for ongoing use. Needs to be a separate website – HAL website too confusing. Not used often enough.
- Limited time for soil pits/workshop – timing needs to be careful. E.g. do in august if going to do.

- Website is novel idea but ½ growers would have access to the internet.
- Should roll out guidelines through existing 2012 program – extension service with federal funding. New Zealand experts do a road show 4 key times of year to key districts. Every three months there is a new strategic message. Should be delivered through this forum as already has a good following. In the next 6 months there is another session in February on maturity and monitoring.
- Don't have manual too thick.
- Not enough people available to just have field sites, visits etc just on water management.
- Printed hardcopy is best way to go. Reference point.
- Website – really handy, but not sure how many would use it. Bit old fashioned.
- Could roll out through Water for Profit program in Queensland – managed by GrowCom. There are 5-6 people employed to provide information on useful aspects e.g. water savings and equipment. Good reference point. Haven't had an event for a while.
- Lots of activities are already happening. Could tie in with an existing program or road show and have a ½ hour session on the guidelines.
- Roll out through existing Future orchards 2012 program. Having a farm walk in February. Had 60 growers last meeting.
- Interactive website would be good and would be best way of displaying tables – only ones relevant to individual growers.

Appendix 4: Final Guidelines