Irrigation Scheduling

WISE **WATERING**
Irrigation Management Course

These materials are part of the Wise Watering Irrigation Management Program, developed in part from the NSW Agriculture WaterWise on the farm education program and The Mallee Wells Irrigators manual.

Course development and presentation by Davey & Maynard, in association with Armstrong Agricultural Services, Serve-Ag, Hinton Agricultural Consulting, Rural Development Services and the Tasmanian Department of Primary Industries, Water and Environment.

The Wise Watering project is part of the Tasmanian Irrigation Partnership Program, funded jointly by the State Government and Natural Heritage Trust.

Natural Heritage Trust
Helping Communities Helping Australia

DEPARTMENT *of* PRIMARY INDUSTRIES, WATER *and* ENVIRONMENT
Tasmania

September 2001

Module notes prepared by

David Armstrong, Armstrong Agricultural Services
Chris Thompson, Serve-Ag
David O'Donnell, DPIWE
Sue Hinton, Hinton Agricultural Consulting

Contents

Introduction

This workshop aims to introduce you to irrigation scheduling, farm water budgeting and benchmarking.

Using these tools will improve your irrigation management and crop performance.

Learning outcomes

By the end of this workshop of the *Introduction to Irrigation Management* course you will be able to:

- determine crop water requirements
- compare irrigation scheduling methods and tools
- develop an irrigation schedule
- develop a seasonal irrigation budget
- identify the benefits of water use efficiency benchmarks for your farm
- identify the information you need to benchmark water use efficiency for your farm.

To achieve these outcomes, workshop activities include determining crop water requirements, developing a sample irrigation schedule, reading and interpreting scheduling tools, completing calculations for a seasonal irrigation budget, and using a data collection sheet for benchmarking information.

Assessment

In this workshop, you complete the assessment by participating in class discussion and completing the worksheets provided for the activities. Activities must be completed and submitted for assessment. Completion of these tasks will be checked during this workshop and at the beginning of the next workshop.

Additional reading

Bill Cotching, DPIWE. "Getting Irrigation Right, Irrigation using tensiometers and evaporation pans".

Crop water use

For given climatic conditions, crop water use depends on the type of crop and its stage of growth.

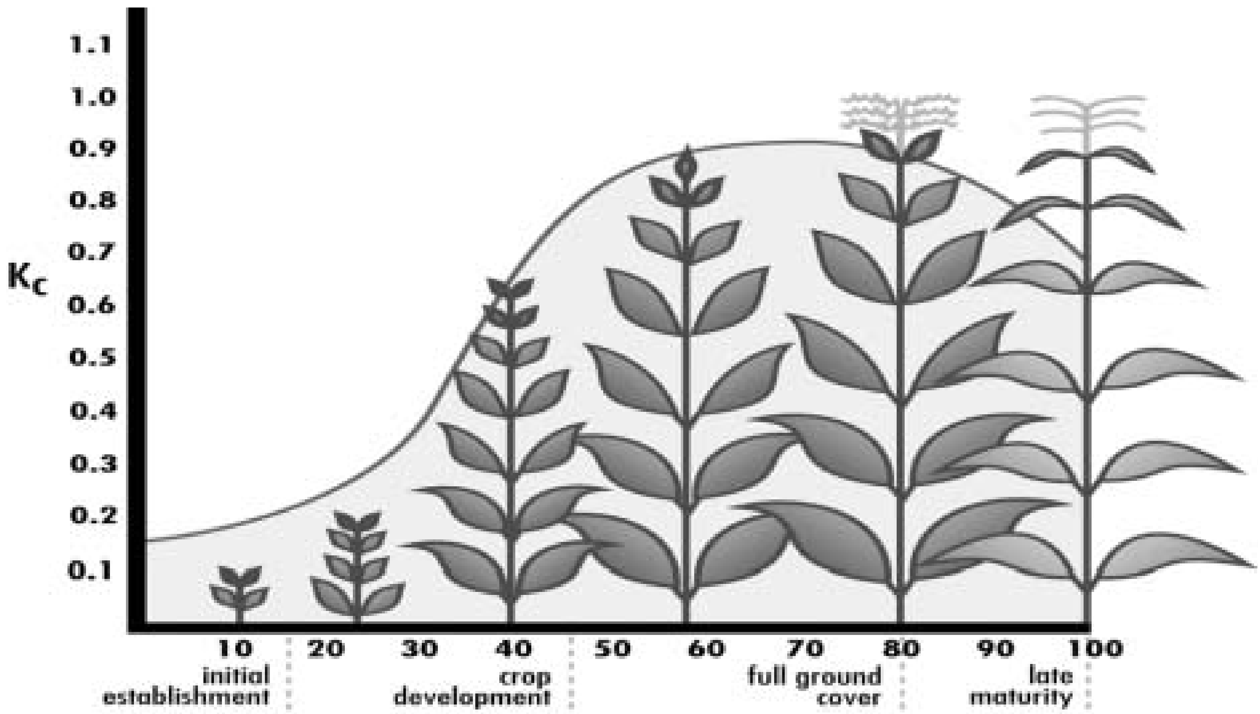
Water evaporates from the soil and is used by the plant by **transpiration**.

Evapotranspiration is a term used to describe the combined losses of water vapour from soil (evaporation) and through plants (transpiration).

Crop growth stages

Figure 1 shows how crop water use changes with crop growth stages. In the early stages of growth, the water requirements are low. Much more water is needed later, nearer crop maturity, and then water use tapers off. The amount of water used varies according to crop and environment: for example, at peak growth, a lucerne crop uses about twice as much water as a grape crop.

Figure 1. Variation in crop water use over the growing season



1.1
1.0
0.9
0.8
0.7
Kc
0.6
0.5
0.4
0.3
0.2
0.1
10
20
30
40
50
60
70
80
90
100
initial establishment
crop development
full ground cover
late maturity
% completion of growing period

What drives crop water use?

Crop water use is driven by the weather conditions of its environment:

∉ **Solar radiation** provides the energy that drives water use. The energy received, and therefore water use, may also be affected by **aspect** of the crop to the sun.

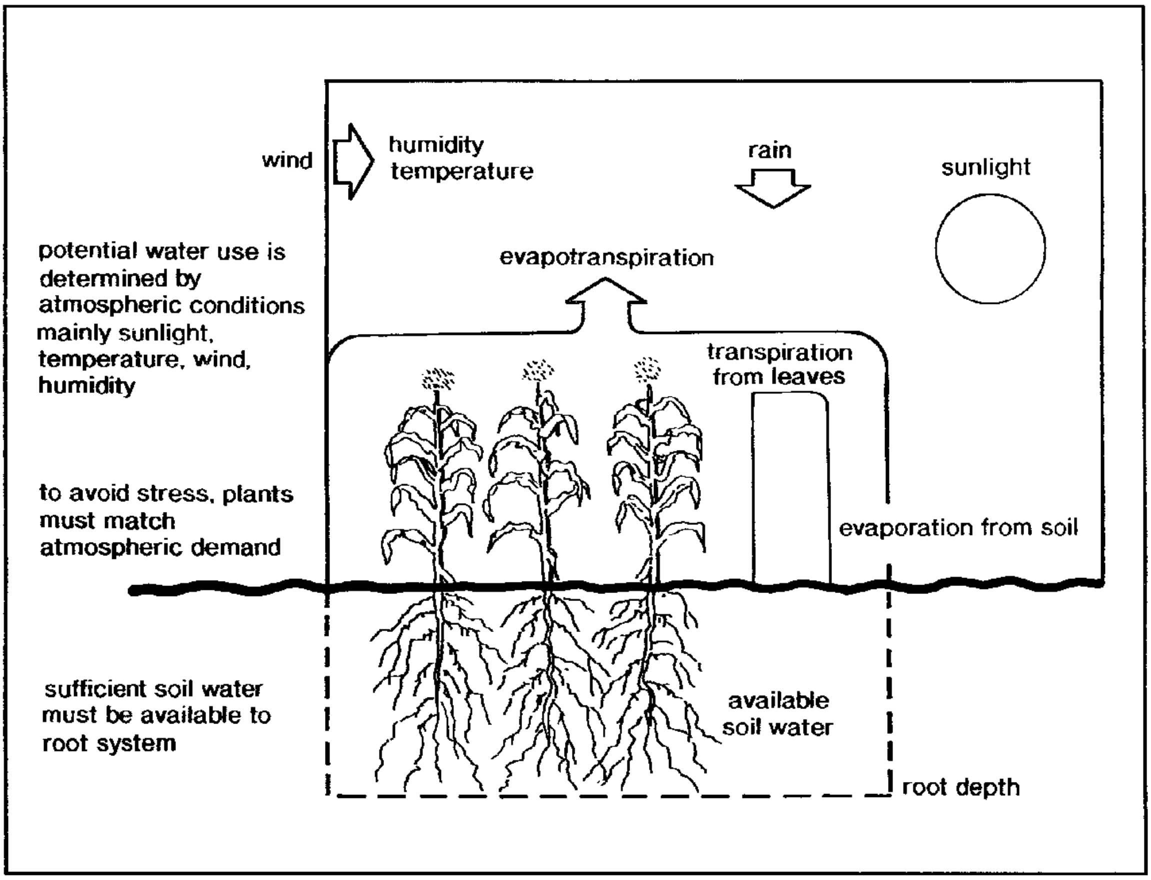
∉ **Humidity:** In a high humidity environment, a plant uses less water than it does at the same temperature in a dry environment, because the air surrounding the plant is less able to remove the water vapour coming out of the plant's leaves.

∉ **Wind speed:** Evapotranspiration increases with wind speed, because the wind removes the vapour that the plant is transpiring.

∉ **Temperature:** Hotter temperatures increase the rate of photosynthesis.

These four aspects of the crop's environment, which combine as evapotranspiration, set the peak water use for the crop. Some **farming practices** (such as tillage, cover crops, fertiliser, pest and disease management, plant density) can affect how closely actual water use approaches peak rates.

Figure 2. Factors affecting crop evaop-transpiration



Calculating crop water use with weather data

Crop water use can be estimated from weather data such as pan evaporation. This relies on the use of a Pan Coefficient that relates Reference Crop Evapotranspiration (ET) to the evaporation measured in the pan, and a Crop Factor that relates crop water use to Reference Crop ET.

Pan Coefficients depend on the exposure of the pan, wind velocity and humidity. A coefficient of 0.85 is common.

Crop factors vary greatly during the season, and at best are rough estimates.

Given the estimates involved, it is reasonable to simply apply the Crop Factor to pan evaporation, and revise the factors during the growing season by experience and observation.

Crop factors in the following table can be used as a guide.

Table 1. Monthly crop factors for a range of irrigated crops.

Month	Vines (1)	Lucerne and pasture	Potatoes
September	0.10	0.75	
October	0.23	0.85	
November	0.30	0.95	0.2
December	0.40	1	0.7
January	0.4	1	0.9
February	0.4	0.9	0.7
March	0.30	0.85	
April	0.23	0.8	

(1) A Grapegrowers Guide, NSW Dept. of Agriculture, 1993.

In some areas "Reference Evapotranspiration" figures are published. The figures indicate water use by a standard crop such as well irrigated pasture. To use these figures you also need to apply a Crop Factor that relates the water use of your crop to that of the reference crop.

An alternative to a Class A pan is to use a 200 litre drum cut in half. The evaporation from the drum is close to the water use by a vigorous crop with full ground cover. The simplest procedure is to cut a V notch 12-15 mm deep in the rim so that surplus water or rain can overflow.

The bottom of the V notch represents Field Capacity. Water is used from the soil at a similar rate to evaporation from the drum. Horizontal lines or a ruler inside the drum can be used to measure the evaporation. When the level falls to the "Refill Point" the crop should be irrigated and the drum filled to overflow that V notch.

To use the daily evapotranspiration figures it is necessary to maintain a water budget as shown in Table 1. This example assumes 42 mm of Readily Available Water (RAW).

Table 2. Sample scheduling sheet

	A	B	C	D	E	F
Date	Pan Evap (mm)	Kc	ET crop (A x B)	Effective rain or irrigation (mm)	Daily change in water balance (D – C)	Remaining available water (F + E) (carry over 5.8)
1 Jan: 6 am.	7.2	0.8	5.8	--	-5.8	0 (refill point)
1 Jan: 6 pm.				7-hour irrigation applies 42 mm	+ 42	42 (profile full)
2 Jan	10.1	0.8	8.1		-8.1	33.9
3 Jan	8.3	0.8	6.6		-6.6	27.3
4 Jan	11.3	0.8	9.0		-9.0	18.3
5 Jan	8.8	0.8	7.0		-7.0	11.3
5 Jan	**			Rain, 20 mm, 15 mm effective	+ 15	26.3
6 Jan	3.6	0.8	2.9		-2.9	23.4
7 Jan	8.5	0.8	6.8		-6.8	16.6
8 Jan	7.7	0.8	6.2		-6.2	10.4
9 Jan	8.0	0.8	6.4		-6.4	4.0
10 Jan	8.9	0.8	7.1		-7.1	-3.1
10 Jan				7-hour irrigation	+ 42	38.9 (profile nearly full)
11 Jan	6.0	0.8	4.8		-4.8	34.1
12 Jan	10.0	0.8	8.0		-8	26.1
12 Jan				Rain, 25 mm	+ 25	42 (profile full + run-off)
13 Jan	7.0	0.8	5.6		-5.6	36.4

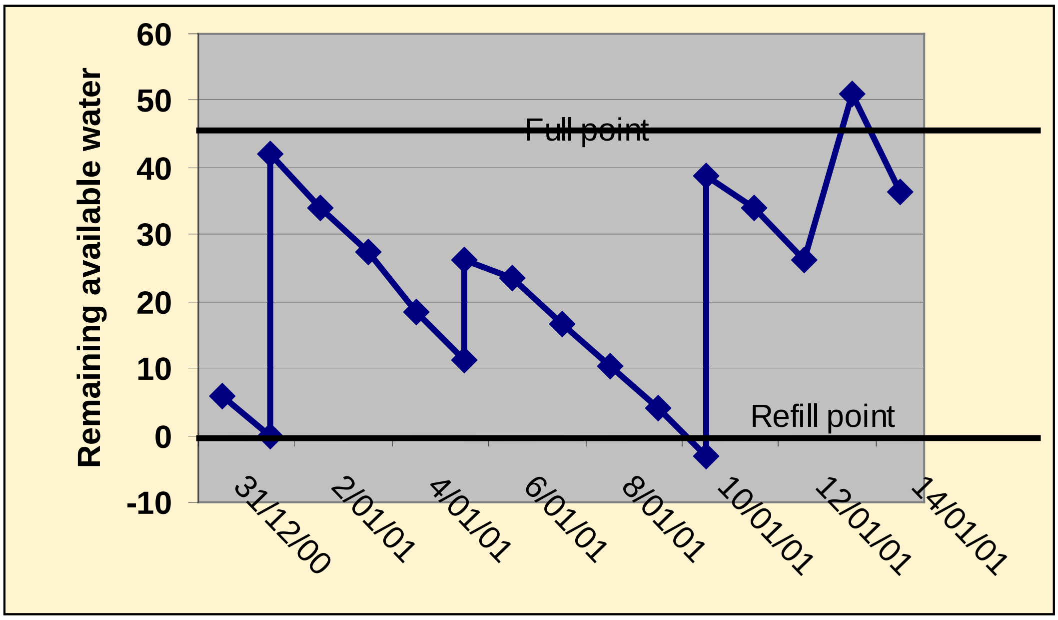
** Not all rainfall is effective; usually the first 5 mm in any day is ignored.

This budget is maintained on a daily basis. When the RAW is used then irrigation is required. If the amount of irrigation is sufficient to return the rootzone to full then the available water is restored.

Estimates of reference crop Evapotranspiration and published weekly during the irrigation season in the Tasmanian Country newspaper. These figures can be used to indicate average daily ET for use in a daily budget like that shown above.

This method has been recommended for decades, but is little used because of the inherent inaccuracies and the requirement for daily book-keeping.

Figure 3. Plot of Column F: Remaining available water



Estimating crop water use by examining the plant

Some farmers may irrigate when a section of a crop starts to show wilting, and due to light soil types and therefore less soil water in the rootzone this is a good indicator for the rest of the paddock if it has better soil and therefore more soil water.

In many cases, however, waiting until the plant wilts means that crop water use has already slowed, reducing the final yield or quality.

Wilting can also be a sign of waterlogging or root disease; also, some plants roll their leaves on a hot, windy day despite the fact that soil water content is adequate, whilst other plants only show wilting when water is severely limited.

Because of these factors, monitoring the plant is **not** recommended as the only or prime method of monitoring crop water use.

More technologically advanced methods of plant monitoring, including sap flow and pressure bomb meters, do work well, but are not in common use by farmers.

Measuring crop water use with soil water monitoring tools

Three basic methods of determining the volume of water in the soil are:

1. **gravimetric,** as with a digstick or drying a soil sample in an oven.

2. **volumetric,** using nuclear or electrical capacitance methods (ADCON, Gopher and Diviner instruments).

3. **tension,** such as in tensiometers or gypsum blocks. Tension is the effort a plant needs to use to extract water.

New soil water monitoring tools are constantly becoming available and each has advantages and disadvantages. The capacitance instruments offer a cost effective and reliable means of irrigation scheduling based on soil moisture levels.

Tensiometers have been used to measure the soil moisture tension. This is a direct measure of the force that plants have to exert to extract moisture.

Guidelines have been developed for the sandy loam and clay loam soils commonly irrigated in Tasmania.

Table 3. Soil moisture tensions to start irrigation.

Irrigated vegetables on Krasnozems, tensiometer at 30 cm	Irrigate at 50 cb (centi-Bars)
Irrigated vegetables on a sandy loam (eg., Cressy loam), tensiometer at 30 cm	Irrigate at 30-40 cb
Irrigated vegetables on light sand (Panshanger sand), tensiometer at 30 cm	Irrigate at 20-30 cb
Pyrethrum on Krasnozems, late in the season	Irrigate at 60-70 cb

Tensiometers fail when the tension (or suction) gets close to 1 atmosphere; air comes out of solution and air pockets prevent the measurement of suction. Regular maintenance is required. Because most of the water available to plants in sandy soils is extracted at low suctions, tensiometers are more reliable in sandy rather then clay soils.

Always install several tensiometers at several locations and several depths, one in the middle of the rootzone, and one near the bottom or just below the rootzone.

Readings should be graphed so you can see the trend, and use this to predict when the next irrigation is due.

Tensiometers have proved useful in potato crops, where a tensiometer placed in the middle of the mound gives a reliable measure of the dryness of the mound.

Other methods have been less reliable in monitoring the moisture level in the mounds.

Selecting sites for soil water monitoring

When monitoring soil water the measurements only sample a small amount of soil. To ensure maximum benefit, it is important to select monitoring sites which are representative of the irrigated area. Selecting monitoring sites is easier on properties where soil surveys have been conducted and water distribution uniformity is good.

Wheel tracks and areas where soil is compacted should be avoided, as should disturbed soil, outside rows, or areas near stunted or sick plants.

Placing the soil water monitor in a 'representative' site means knowing how the location relates to the rest of the field. You are trying to select a soil type that indicates the water-holding capacity for the area, making sure the location includes the whole rootzone of the crop, and supports a crop of a height and yield that is average for the area.

It is advisable to use more than one sensor in each paddock. Capacitance probes, for example, can be strongly influenced by air gaps between the access tube and the surrounding soil (so care in installation is necessary). But it is safer to have two or three access tubes in each paddock or irrigation block.

If you are using more than one sensor site, you could try to get a better idea of what is happening across the whole area by locating sensors in, for example, the higher/lower or drier/wetter parts of the field.

What do soil water monitoring tools tell us?

A soil water monitoring tool shows how the water content varies at different depths and over time. Figures 4 and 5 show water content varying with depth, and soil water readings over time.

Figure 4. Soil water content varying at different depths

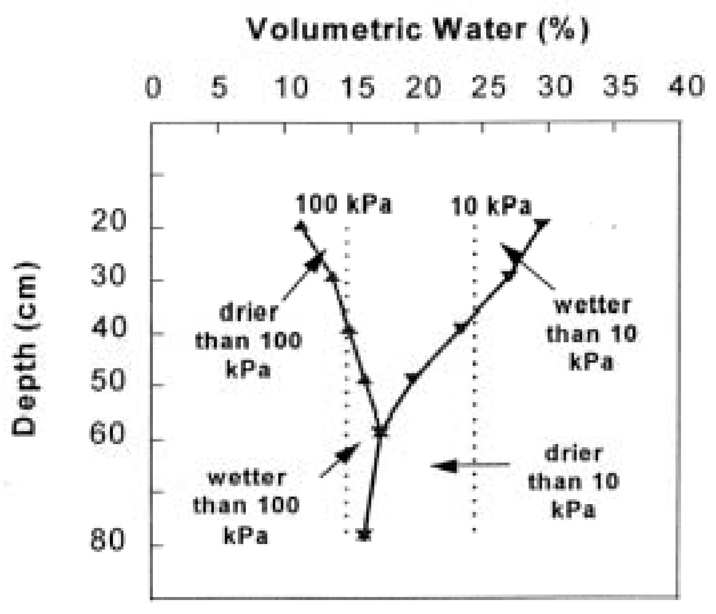
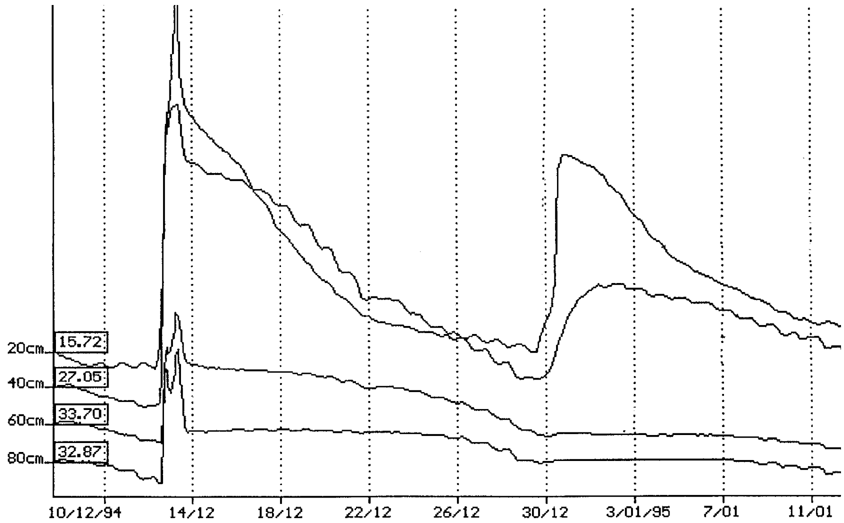
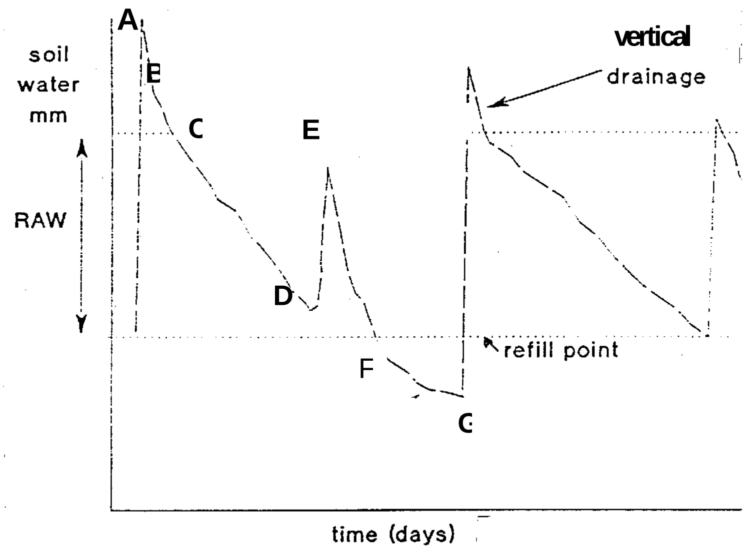


Figure 5. Soil water readings at several depths over time



In figure 6, a plot logged by computer from a soil water monitoring tool, you can see the cycle of irrigation and drying over time. The soil water is topped up through irrigation or rain, then used by the crop (or lost as run-off or drainage).

Figure 6. Cumulative soil water readings



A to B

Immediately after the initial irrigation, water exceeds the ‘full point’ and some is lost to vertical drainage. Water is not available to the crop while there is no oxygen in the soil.

B to C

Slower drainage of excess water down to field capacity.

C to D, and **E to F**

Unrestricted growth, with water readily available.

D to E

Rain entered the profile after D.

F to G

The readily available water has been used and the crop has difficulty extracting more. The daily use is lower and the crop is becoming stressed.

This cycle is repeated throughout the season.

More detailed training in the use of soil capacitance instruments (Gopher and ADCON) is provided in subsequent sessions.

Irrigation scheduling

An irrigation schedule predicts when the crop needs its next irrigation, and the amount required. Irrigation scheduling is a process of fine-tuning to achieve the quality and yields required, and uses data on crop water use. Figure 5 illustrates how yield is affected by too little or too much water.

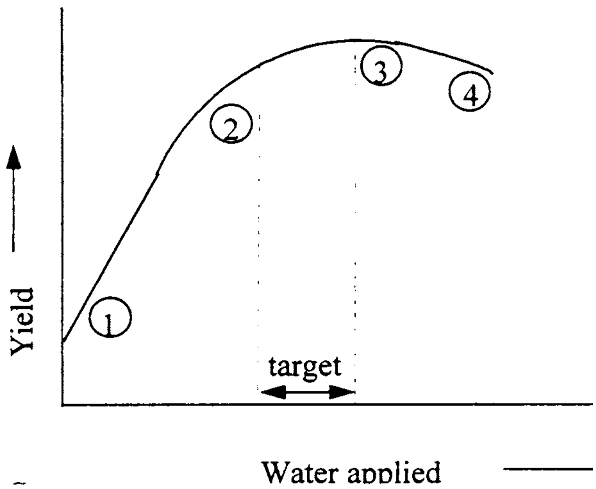


Figure 7. Theoretical relationship between water applied and yield.

1. Yield increases without irrigation
2. Irrigation contributes to continued yield increase
3. More water causes no increase in yield
4. Too much water and yield declines due to waterlogging

When both weather data and soil water monitoring tools are available for irrigation scheduling they are often used for cross-checking crop water use in the particular situation. This is particularly the case with high value crops.

Effective irrigation scheduling generally aims to avoid stress to the plant, although specialised management techniques may be used in some crops or where water resources are limited.

For instance:

Vines: Although it is accepted practice to avoid water stress during flowering, fruit quality can be improved by stressing the plant at certain stages of growth. Seek further information if you are interested in these techniques.

Stone fruit: Avoid any water stress during flowering and keep water up during the 4-6 weeks prior to harvest to ensure adequate fruit size.

Vegetables: Avoid any water stress during the life of shallow-rooted plants as it can lead to a reduction in yield.

Water budgeting

Water budgeting is estimating

1. how much crop can be grown with the available water (particularly relevant for annual crops), or

2. how much water is needed to achieve the required quantity and quality.

Water budgeting allows you to plan your irrigation management and make the changes you needed during the season.

The factors that help determine the water budget are
- the local climate
- the annual requirements of the crop
- the available supply

Local climate
- What is the average rainfall?
- What is the probability of above or below average rainfall?
- When does rainfall occur – how will this affect irrigation and dam supplies?

Annual requirements of the crop
- Do you know the annual requirements for your crop
- What scope is there to adjust water within acceptable quality and quantity boundaries

Available supply
- How much stored water is available?
- How much water will be lost from the storage by evaporation?
- How much water can be pumped from streams or bores?
- Can water be transferred or purchased? How much will this cost versus the benefits?
- Is water quality an issue at low flows?
- What are the chances of summer "freshes"?

It is often not easy to estimate all these amounts. The amount of water stored is often over-estimated. The capacity of dams is best determined by a survey of the dam (particularly if this was not done prior to construction).

A rough figure of evaporation loss is to allow 66% of the annual evaporation and apply it to the top surface area of the dam. So for a dam with a surface area of 1 hectare, and annual evaporation of 1,100 mm (most of Tasmania has evaopration between 1,000 and 1,200 mm) indicates an evaporative loss of approximately 725 mm per hectare of surface area. This is equivalent to 7.25 ML/hectare of surface area.

Calculating the water budget

At the beginning of each season you need to estimate what area of crop you can irrigate if you account for all of the factors. Divide the total amount of water available by the amount of irrigation water you expect your crop to use for the season.

In water budgeting, you need to consider the overall efficiency of your system and, allowing for this, you can estimate the maximum area of crop you can irrigate.

Example 1:

You are growing pasture under spray irrigation and you have 60 ML available. Your system is about 80% (0.8) efficient; ie., about 80% of the water that you pump reaches the rootzone of the pasture.

Pasture requires about 5 ML/ha of irrigation water in a season of average rainfall in most areas of Tasmania. Assuming the water is available from a stream or bore or district Scheme, the maximum area that can be watered is:

$= (60 \Delta 0.8)/5$ = **9.6 ha**

Example 2:

You have a dam with capacity of 75 megalitres and surface area of 3.2 hectares. The maximum depth of the water is 7 metres.

Note. You can check the dam capacity as with the following formula;

Volume = Surface area (sq.metres)*maximum depth/3
= 3.2*10,000*7/3
= 74,667 cubic metres
= 75 megalitres

Evaporation loss = surface area (ha) * 6.25
= 23 ML

If there is no inflow into the dam during the season (either from springs or runoff) then the amount available for irrigation is 52 ML.

The evaporative loss is over-estimated if the irrigation is conducted mainly in the early summer (November to January); as is common with many crops.

Assume your system is about 90% (0.9) efficient and you are planning to irrigate 12 hectares of potatoes and 15 hectares of peas.

Water requirements for potatoes are approximately 3.75 ML/ha; total 45 ML.
Peas @ 1.5 ML/ha; 22.5 ML.
The total requirement is therefore 67.5 ML, which significantly exceeds the amount available (52 ML).

How would you respond to this deficit?

You could reduce the area of either crop. Or you could reduce the planned water application by stressing the crops between irrigation. This is probably not the best strategy (this will be discussed in the Crop Management Module).

You could look for more water, by establishing an arrangement with a neighbour to buy water, or drill looking for groundwater.

Or you could continue with the proposed areas and pray for rain!

Activity 1: Calculating crop water use from weather data

On the example worksheet (Irrigation scheduling data sheet) that follows, you will notice the information has partially been filled in. You will need to supply the basic information such as RAW and ETo when you develop a schedule for you own irrigation blocks.

Step 1 Calculate the ETcrop from the 13th through to the 19th. Enter this in column C

Step 2 Enter the 'Daily change in water balance' in column E from 11th through to 19th

Step 3 Complete Column F and add an irrigation amount to Column D where it is required.
(You will also need to update Column E for the dates irrigation occured)

Step 4 Check out your answers with the answer sheet.

If you have time, continue with the next set of steps.

Step 5 For the next week, 20th to 26th calculate the *average* ETo so far for the month and use this to predict water use for the next week. Enter this in Column A
(Historical data for your district may be available or you can average the earlier part of the month by adding up all the ETo's from 1st to 19th and dividing the result by the number of days)

Step 6 Calculate the predicted ETcrop for the next week. Enter this in column C

Step 7 Complete the rest of the sheet and irrigate when required. (Assume there is no rainfall)

Irrigation scheduling data sheet: example

Month: **January**	Crop: …….
Block: **West 3**	RAW **42** mm

	A	B	C	D	E	F
Date	ETo	Kc	ET crop (A x B)	Effective rain or Irrigation	Daily change in water balance (D - C)	Remaining water available (F + E) (Carried over 5.8)
1	**7.2**	**0.8**	**5.8**	**7 hrs x 6mm/h irrigation**	**-5.8** **+42**	**0 (refill point)** **42 (profile full)**
2	**10.1**	**0.8**	**8.1**		**-8.1**	**33.9**
3	**8.3**	**0.8**	**6.6**		**-6.6**	**27.3**
4	**11.3**	**0.8**	**9.0**		**-9.0**	**18.3**
5	**8.8**	**0.8**	**7.0**	Rainfall, 15 mm	**-7.0** **+15**	**11.3** **26.3**
6	**3.6**	**0.8**	**2.9**		**-2.9**	**23.4**
7	**8.5**	**0.8**	**6.8**		**-6.8**	**16.6**
8	**7.7**	**0.8**	**6.2**		**-6.2**	**10.4**
9	**8.0**	**0.8**	**6.4**		**-6.4**	**4.0**
10	**8.9**	**0.8**	**7.1**	**7 hrs x 6mm/h**	**-7.1** **+42**	**-3.1** **38.9**
11	**6.0**	**0.8**	**4.8**			
12	**10.0**	**0.8**	**8.0**	Rainfall, 25 mm		
13	**7.0**	**0.8**				
14	**7.0**	**0.8**				
15	**8.0**	**0.8**				
16	**9.0**	**0.8**				
17	**7.0**	**0.8**				
18	**10.0**	**0.8**				
19	**12.0**	**0.8**				
20		**0.8**				
21		**0.8**				
22		**0.8**				
23		**0.8**				
24		**0.8**				
25		**0.8**				
26		**0.8**				
27						
28						
29						
30						
31						

Answer sheet for Steps 1 to 4.

Irrigation scheduling data sheet: example

Month: **January**	Crop**:** **…….**
Block: **West 3**	RAW **42** mm

	A	B	C	D	E	F
Date	ETo	Kc	ET crop (A x B)	Effective rain or Irrigation	Daily change in water balance (D - C)	Remaining water available (F + E) (Carried over 5.8)
1	**7.2**	**0.8**	**5.8**	**7 hrs x 6mm/h irrigation**		**0 (refill point)** **42 (profile full)**
2	**10.1**	**0.8**	**8.1**		**-8.1**	**33.9**
3	**8.3**	**0.8**	**6.6**		**-6.6**	**27.3**
4	**11.3**	**0.8**	**9.0**		**-9.0**	**18.3**
5	**8.8**	**0.8**	**7.0**	Rainfall, 15 mm	**-7.0** **+15**	**11.3** **26.3**
6	**3.6**	**0.8**	**2.9**		**-2.9**	**23.4**
7	**8.5**	**0.8**	**6.8**		**-6.8**	**16.6**
8	**7.7**	**0.8**	**6.2**		**-6.2**	**10.4**
9	**8.0**	**0.8**	**6.4**		**-6.4**	**4.0**
10	**8.9**	**0.8**	**7.1**	**7 hrs x 6mm/h**	**-7.1** **+42**	**-3.1** **38.9**
11	**6.0**	**0.8**	**4.8**		**-4.8**	**34.1**
12	**10.0**	**0.8**	**8.0**	Rainfall, 25 mm	**-8** **+25**	**26.1** **42 (full +**
13	**7.0**	**0.8**	**5.6**		**-5.6**	**36.4**
14	**7.0**	**0.8**	**5.6**		**-5.6**	**30.8**
15	**8.0**	**0.8**	**6.4**		**-6.4**	**24.4**
16	**9.0**	**0.8**	**7.2**		**-7.2**	**17.2**
17	**7.0**	**0.8**	**5.6**		**-5.6**	**11.6**
18	**10.0**	**0.8**	**8.0**	**7 hrs x 6mm/h**	**-8.0** **+42**	**3.6** **42 (full)**
19	**12.0**	**0.8**	**9.6**		**-9.6**	**32.4**
20		**0.8**				
21		**0.8**				
22		**0.8**				
23		**0.8**				
24		**0.8**				
25		**0.8**				
26		**0.8**				
27						
28						
29						

Answer sheet for Steps 5 to 7

This shows the predicted water use using the average ET.

Irrigation scheduling data sheet: example

Month: **January**	Crop: …….
Block: **West 3**	RAW **42** mm

	A	B	C	D	E	F
Date	ETo	Kc	ET crop (A x B)	Effective rain or Irrigation	Daily change in water balance (D - C)	Remaining water available (F + E) (Carried over 5.8)
1	**7.2**	**0.8**	**5.8**	**7 hrs x 6mm/h**		**0 (refill point)** **42 (profile full)**
2	**10.1**	**0.8**	**8.1**		**-8.1**	**33.9**
3	**8.3**	**0.8**	**6.6**		**-6.6**	**27.3**
4	**11.3**	**0.8**	**9.0**		**-9.0**	**18.3**
5	**8.8**	**0.8**	**7.0**	Rainfall, 15 mm	**-7.0** **+15**	**11.3** **26.3**
6	**3.6**	**0.8**	**2.9**		**-2.9**	**23.4**
7	**8.5**	**0.8**	**6.8**		**-6.8**	**16.6**
8	**7.7**	**0.8**	**6.2**		**-6.2**	**10.4**
9	**8.0**	**0.8**	**6.4**		**-6.4**	**4.0**
10	**8.9**	**0.8**	**7.1**	**7 hrs x 6mm/h**	**-7.1** **+42**	**-3.1** **38.9**
11	**6.0**	**0.8**	**4.8**		**-4.8**	**34.1**
12	**10.0**	**0.8**	**8.0**	Rainfall, 25 mm	**-8** **+25**	**26.1** **42 (full +**
13	**7.0**	**0.8**	**5.6**		**-5.6**	**36.4**
14	**7.0**	**0.8**	**5.6**		**-5.6**	**30.8**
15	**8.0**	**0.8**	**6.4**		**-6.4**	**24.4**
16	**9.0**	**0.8**	**7.2**		**-7.2**	**17.2**
17	**7.0**	**0.8**	**5.6**		**-5.6**	**11.6**
18	**10.0**	**0.8**	**8.0**	**7 hrs x 6mm/h**	**-8.0** **+42**	**3.6** **42 (full)**
19	**12.0**	**0.8**	**9.6**		**-9.6**	**32.4**
20	Avg so far 8.3	**0.8**	*6.6*		***-6.6***	***25.8***
21		**0.8**	*6.6*		***-6.6***	***19.2***
22		**0.8**	*6.6*		***-6.6***	***12.6***
23		**0.8**	*6.6*		***-6.6***	***6.0***
24		**0.8**	*6.6*	**7 hrs x 6mm/h**	***-6.6*** ***+42***	***-0.6*** ***+41.4***
25		**0.8**	*6.6*		***-6.6***	***34.80***
26		**0.8**	*6.6*		***-6.6***	***28.2***
27						

Guidelines for completing the Irrigation scheduling data sheet

1. Fill in details of the crop or pasture being irrigated.
2. Record the RAW (mm) for your block.
3. **ONLY if you are using pan evaporation figures,** use a separate sheet to convert each day's evaporation reading to ETo by multiplying the Pan reading by the 'pan factor' for your district. (Ask your irrigation adviser for details.)

Column A: Enter the daily evapotranspiration readings for your district.
Column B: Copy the crop coefficient (Kc) which applies to your crop for the month from the reference your trainer has recommended.
Column C: Multiply the figure in Column A by the figure in Column B to determine crop water use (ET crop) and enter this in column C.
Column D: Enter details of any effective rainfall.
Column E: Show the daily water use. Column D minus Column C. (This will usually be negative except when there is rain or irrigation.)
Column F: Determine the remaining water available for each day (below the Full point) This is the previous day's figure less today's daily water use. (When the water use is positive because of rain or irrigation, you add the amount)
Whenever the figure in column F approaches 0 you need to irrigate to refill the soil profile. If an irrigation does not totally refill the profile you will need to allow for this. For surface systems it is always assumed the profile is filled.
If there are any special conditions, such as leaching requirements, or you are practising RDI, you will need to adjust your scheduling to suit.

Listed below are some Kc figures. For your own scheduling calculations, you should use local figures in preference to those given in the tables. Your local irrigation adviser will be able to provide these figure.

Irrigation scheduling data sheet:

Month:	Crop:
Block:	RAW...................mm

	A	B	C	D	E	F
Date	(ETo)	(Kc)	ET crop (A x B)	Effective rain or Irrigation	Daily change in water balance (D - C)	Remaining water available in paddock (F + E) (Carried over ……)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						

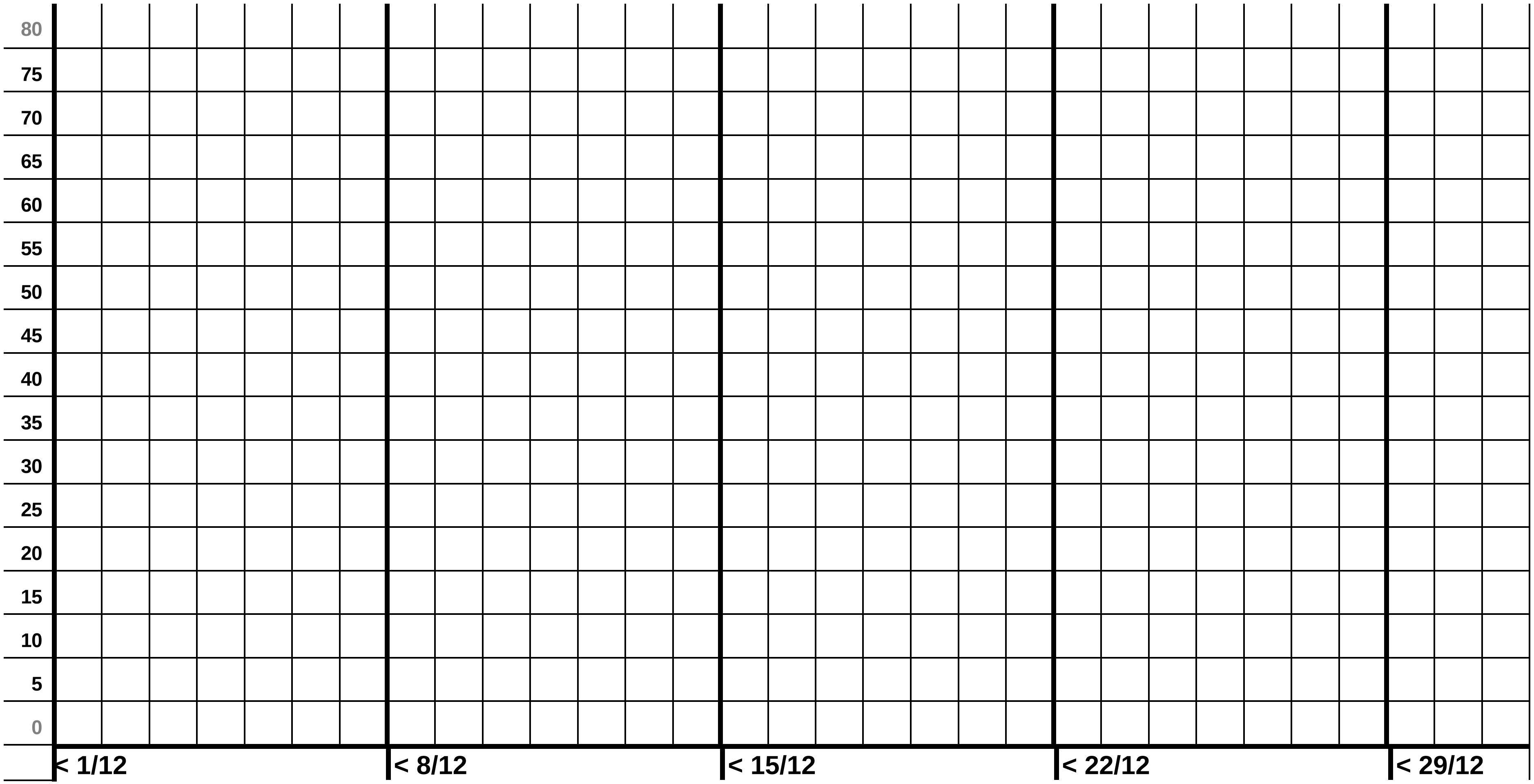
Activity 2A: Calculating crop water use from soil moisture data

Step 1. Using the data below, (collected from a soil based monitoring tool) fill in the 'Remaining water available" column (the first 3 have been done for you)
Step 2. Plot the water usage on the following blank chart.

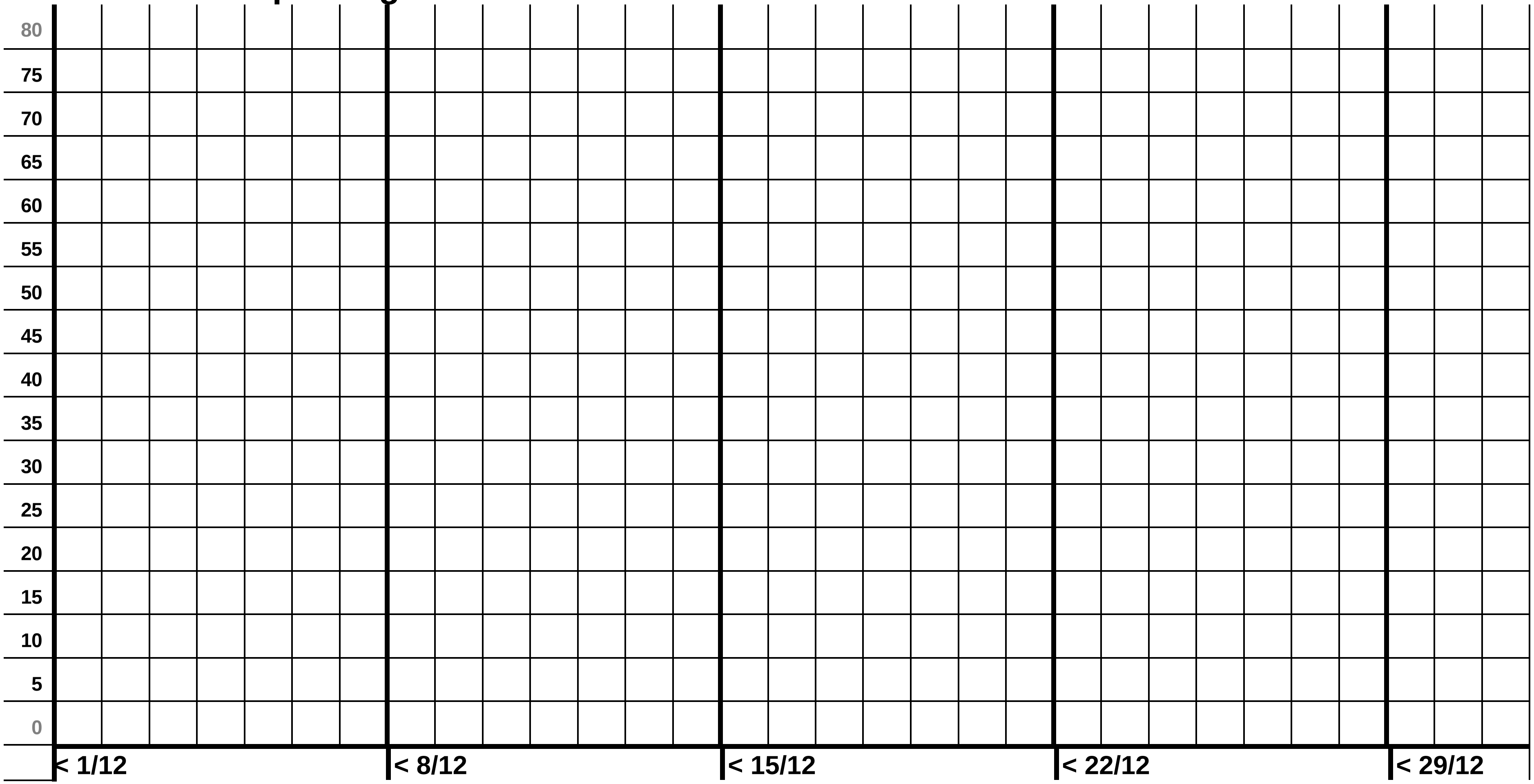
Note that in this case the soil is assumed to have a RAW of 37 mm so the **FULL point is at 37 mm** with the **REFILL point at 0 mm**. Draw a line across your chart at each of these levels.

Date	Daily crop water used mm	Rainfall mm	Remaining water available	Irrigation needed ??
Full Irrigation on 30th November so Profile is now Full at 37 mm				
1/12	5		32	
2/12	4		28	
3/12	3		25	
4/12	6			
5/12	4			
6/12	5			
7/12	5	20		
8/12	3			
9/12	2			
10/12	3			
11/12	7			
12/12	5			
13/12	5			
14/12	2			
15/12	3			

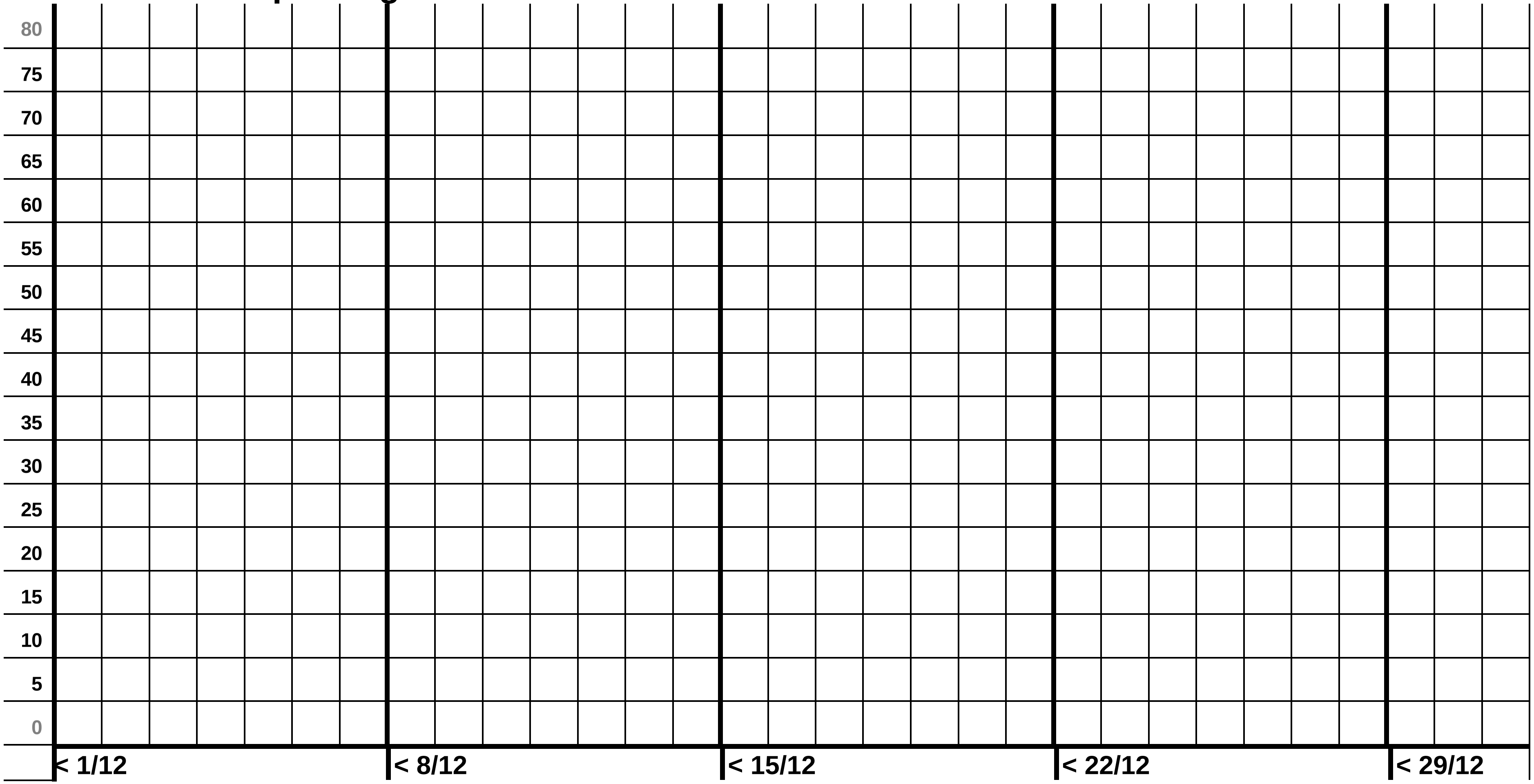
Blank chart for plotting data.



Blank chart for plotting data.



Blank chart for plotting data.



Activity 2B: Plotting crop water use from tensiometer readings (kPa)

The purpose of this activity is to plot and interpret readings from two tensiometers placed at a site at depths of 30, 60 cm
Assume the soil profile requires refilling when the suction is at **40kPa,** and the profile is full when the suction is down to only **8 kPa**.

Step 1. Using a blank chart draw a line across at the Refill and Full points (8kPa and 40kPa)
Step 2. Plot the tensiometer readings from the table below and join the points. Use a different colour or shaped line for the 30 and 60cm tensiometer readings.
Step 3. When you have completed this, discuss the results, and decide if the irrigation could have been managed more effectively.

	30 CM	60 cm	
	kPa	kPa	
1	6	30	
2			
3			
4			
5	22	42	
6			
7			
8			
9	56	61	7 hr Irrigation
10	3	40	
11	6	10	
12			
13			
14	33	18	3 hr Irrigation
15			
16	7	23	
18			
19			8 mm of effective rainfall
20	17	29	
21			
22			
23			
24	25	34	
25			
26	50	40	6 hr Irrigation
27			
28	5	8	
29			
30			
31	16	14	

The table below shows you how to interpret tensiometer readings.

Readings (cb or kPa)	**Interpretation**
0 to 10	Soil is very wet. Continual readings in this range indicate excessive irrigation and waterlogging. Plant root damage highly probable
10 to 25	Best balance of soil moisture and air. Ideal for plant growth.
25 to 40	Soil moisture sufficient for plant growth. May need to irrigate on light soils.
40 to 60	Soil is getting dry. Crops are probably stressed. Crops should be irrigated in this range.
Over 60	Irrigate before this level is reached!
Tensiometer gauges measure negative pressure, or suction. Gauges do not normally display the '-' sign that you may see in written material, for example –20 kPa.	