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Preparing a water budget

A water budget needs to be prepared at the beginning of each season to estimate how much cotton can be grown with the available water. A water budget is part of risk management - that is, it helps to reduce the risk of not having enough water to finish a crop.

To prepare a water budget you need to know 1) your seasonal crop water requirements; 2) the climate and its variability; and 3) the available water supply.

Seasonal Crop Water Requirements:

Understanding crop water requirements (ETc) is crucial for planning your mix of crops, the area to be planted and how irrigation is managed. Table 1 shows the water requirements for a variety of crops.

The total seasonal crop evapotranspiration is an accumulation of the daily crop ETc over the whole season. This figure will vary from crop to crop and from year to year, but will typically be within the range provided in Table 1.

Table 1: Water Requirements of Crops (WATERpak Table 2.1.2)

Crop	Crop Evapotranspiration Requirement[1] (mm)	Peak Daily Water Use (mm/day)			Critical Irrigation Periods
		ET_o = 6mm	ET_o = 8mm	ET_o = 10mm	
Barley**	350 to 500	6.9	9.2		Shot – blade to late flowering
Chickpeas**	350 to 500	6.0	8.0		4 to 5 weeks after flowering
Cotton***	650 to 770	6.9–7.2	9.2–9.6	11.5–12	Peak flowering and early boll development
Maize*	600 to 850	7.2	9.6	12	Tasselling through seed fill
Sorghum*	450 to 850	6.0–6.6	8.0–8.8	10–11	Boot to dough stage
Soybeans**	500 to 775	6.9	9.2	11.5	Flowering to leaf drop
Wheat**	350 to 500	6.9	9.2		Boot stage and flowering until soft dough stage

1. The crop evapotranspiration is the demand that must be met by in-season rainfall, irrigation and stored soil water at planting.
Sources: *Pacific Seeds 2006-07 cropping yearbook; **Graham Harris, DPI&F, pers.comm; ***WATERpak 2013.

A crop's requirement for water changes throughout the growing season, following the pattern of evapotranspiration (Crop Water Use) as shown in Figure 1 (below). The rate of evapotranspiration is determined primarily by the size and stage of the crop, meteorological factors and the availability of soil water.

Tools such as CropWaterUse are available to help growers calculate the theoretical daily and seasonal water use of a crop for a range of crops, including cotton. You can access CropWaterUse at www.cropwateruse.net.au.

The IrriSAT technology also provides a method for estimating crop water use, where remote sensing is used to determine site specific crop coefficients, providing a locally derived crop evapotranspiration (ETc) or daily crop water use. You can access IrriSAT at https://irrisat-cloud.appspot.com.

The climate and its variability

Once you understand how much water your crop is going to use, it can be adjusted for the expected seasonal conditions, hence you need an understanding of climate variability for your region.

This requires knowledge of your regions median rainfall, the probability of above or below median effective rainfall and when rainfall occurs (how will timing affect irrigation, dam supplies or extraction limits).

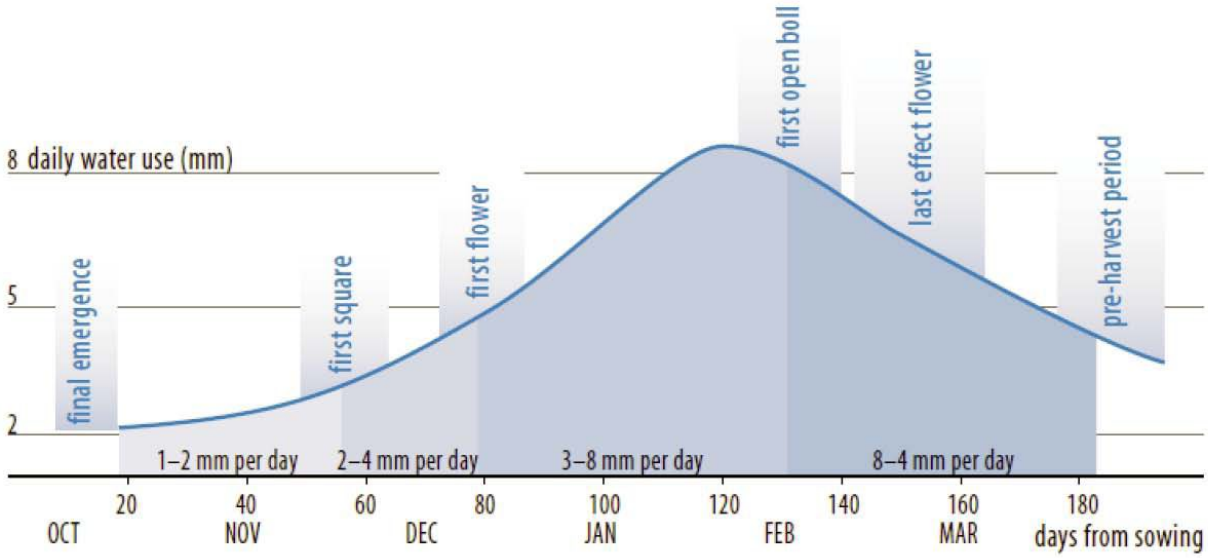
Investigating climate forecasts (3-monthly rainfall and temperature), past rainfall records and current climatic patterns may help predict what sort of season you could expect eg wetter or dryer than a median year, and plan accordingly.

CottonInfo publishes a fortnightly e-newsletter, the CottonInfo Moisture Manager, to provide the latest climate and forecasting information to growers. You can access previous editions of the Moisture Manager, and sign up for future editions, at: www.cottoninfo.com.au/moisture-manager-e-newsletter.

Available water supply

Finally you must know your available water supply, ie irrigation water (regulated and unregulated rivers allocation), on-farm capture, total storage capacity and ability to trade water. Don't discount the importance of understanding how much soil moisture you have available for your crop. A full profile at the start of the season can reduce your total irrigation water requirements.

Figure 1: Nominal seasonal Daily Water Use (mm/day) for cotton production (WATERpak, Figure 2.1.3).



Budgeting methodology
The maximum area of crop that can be irrigated is determined by crop water requirements, the irrigation system capacity and efficiency and the availability of water.

Area = Irrigation water available / annual crop water requirement × irrigation system efficiency.

For example: A cotton crop in Southern QLD might require about 900mm (9ML/ha) of water. Historical figures indicated that the median rainfall during the season for this location is 350mm (3.5ML/ha). So for a median year the irrigation requirement is 5.5ML/ha.

At planting, the grower has 300ML in storage and 700ML of available allocation. The grower estimates that another 500ML will be harvested during the season.

Irrigation water available: 1500 ML
Irrigation requirement: 5.5ML/ha
Whole Farm Efficiency: 64 per cent, ie 36 percent of irrigation water lost through deep drainage, in-field leaching and evaporation and seepage from on farm storages and channels.

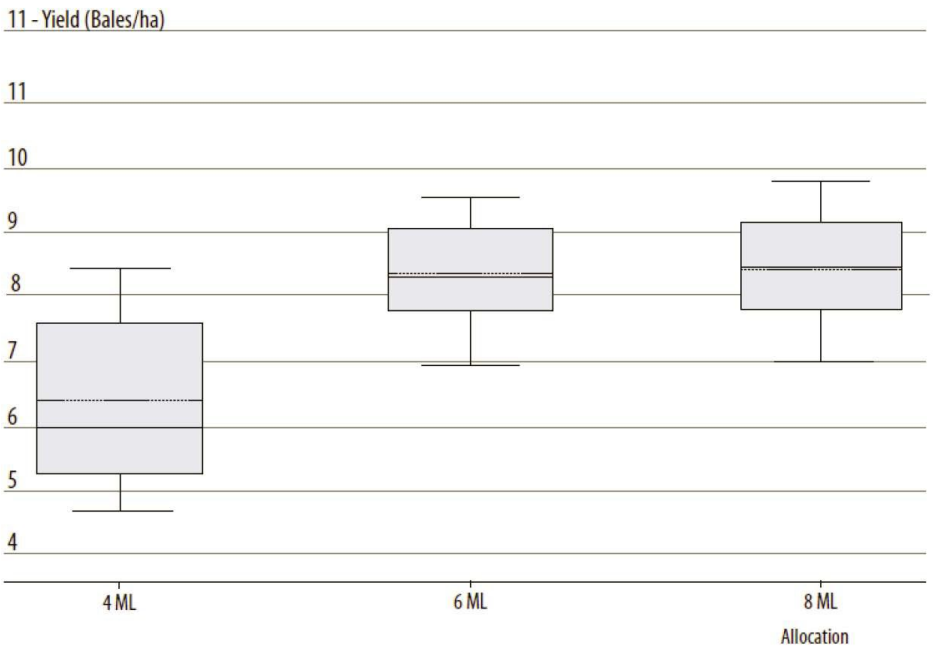
Area = 1500 ÷ 5.5 × 0.64 = 175 ha.

A number of studies have been undertaken to consider the area to dedicate to irrigated cotton production and have found that at least 5 to 6ML/ha of water supply is required. Refer to Table 3.3.1 in WaterPAK for more information.

Water budgeting tools
A number of tools can be used to help produce a water budget. For example, crop modelling tools such as CottBASE (available through CottASSIST www.cottassist.com.au), WaterSched2 (www.watersched.net.au) and WhopperCropper (for rain-fed crops, www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/cropping-efficiency/whoppercropper) can be used to predict likely yield given different conditions and available water inputs.

From these predictions, you can choose an amount of water to allocate to each field and compare different scenarios in terms of final yield and seasonal water use, as illustrated in Figure 2.

Figure 2: CottBASE comparison of predicted yield for multiple scenarios of available irrigation water.



The 25th and 75th percentile figures are used to indicate the likely range of values that might be expected. For example, in Figure 2, for this particular scenario using CottBASE, if you have 6ML/ha available, the yield is likely to fall between 7.8 and 9b/ha.

An example of how to use CottBASE data to compare the economics of various irrigation allocations is provided in Table 2.

Table 2: An example method for comparing the economics of various irrigation allocations using data from CottBASE.

Allocation	TOAL	Cotton Area	Yield (Bales/ha)			Range	Total Bales		
ML/ha	(ML)	(ha)	25%	Average	75%	Bales / ha	25%	Average	75%
4	1000	250	5.2	6.4	7.6	2.4	1300	1600	1900
6	1000	167	7.7	8.4	9.1	1.4	1283	1400	1517
8	1000	125	7.7	8.5	9.1	1.4	963	1063	1138

Return @$400/bale			growing costs	Total	Gross Margin ($)		
25%	Average	75%	$ / ha	Cost ($)	25%	Average	75%
$520,000	$640,000	$760,000	$2,268	$567,000	-$47,000	$73,000	$193,000
$513,333	$560,000	$606,667	$2,520	$420,000	$93,333	$140,000	$186,667
$385,000	$425,000	$455,000	$2,800	$350,000	$35,000	$75,000	$105,000

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Download:

- WATERpak: www.cottoninfo.com.au/publications/waterpak (see Section 1.2 Water use efficiency, benchmarking and water budgeting and Section 2.3 Irrigation decision support tools).

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