BENEFITS OF MANAGING SOIL WATER DEFICITS FOR PRODUCTION & ENVIRONMENTAL GOALS

Applying the right amount of irrigation at the right time without filling the soil profile reduces unintended environmental impacts: nutrient leaching, emission of nitrous oxide (potent greenhouse gas) and soil damage by compaction.

Allowing soils to dry more (build up a soil water deficit) provides an opportunity to capture and store rainfall. Benefits include:

- fewer irrigations
- reduced pumping saving money
- reduced nutrient losses and greenhouse gas emissions without losing crop or pasture production.

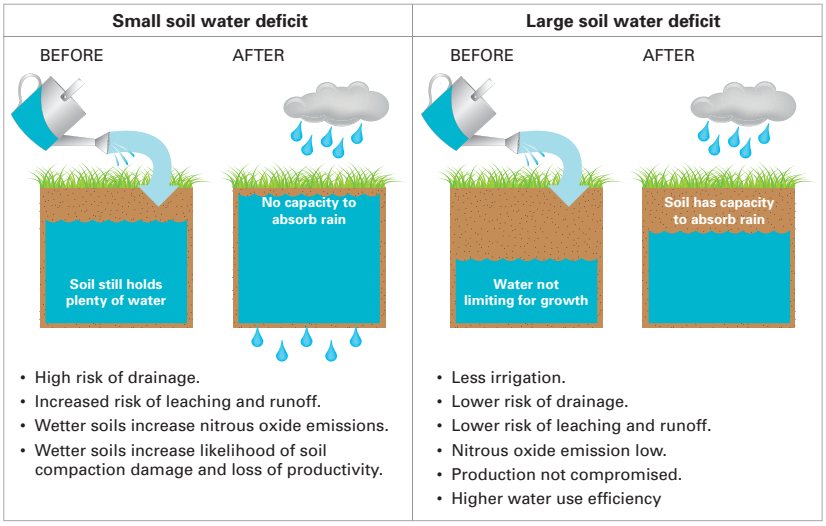
It also means more water can be allocated to other paddocks or crops, creating a win-win for production and the environment.

The key periods to target are the spring and autumn "shoulders" when plant water use (evapotranspiration, ET) is lower than during mid-summer. Over these periods there is more opportunity to reduce the amount of irrigation and benefit from rainfall by not refilling the soil profile to field capacity.

An ability to manage irrigation while maintaining soil water deficits over summer periods when plant water use is greatest will depend on:

1. the capacity of the irrigation system
2. the soil's water storage capacity
3. the ability of roots to extract soil water fast enough to keep up with plant demand.

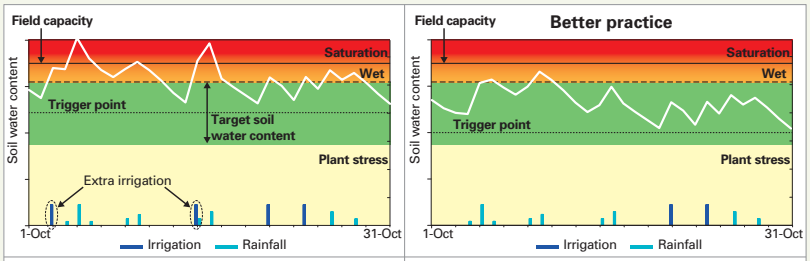
As a general rule plants can extract up to 10% of available soil water per day; i.e. if the plant demand is 5 mm of water per day then 50 mm of stored available soil water is needed.



- High risk of drainage.
- Increased risk of leaching and runoff.
- Wetter soils increase nitrous oxide emissions.
- Wetter soils increase likelihood of soil compaction damage and loss of productivity.

- Less irrigation.
- Lower risk of drainage.
- Lower risk of leaching and runoff.
- Nitrous oxide emission low.
- Production not compromised.
- Higher water use efficiency

An example of how triggering irrigation at a greater soil water deficit in spring (right hand panel) can reduce irrigation, drainage, leaching losses and nitrous oxide emissions compared with refilling the soil at each irrigation (left hand panel). The redder shading indicates greater risks of leaching and nitrous oxide emissions. In this example, for a shallow soil of low water holding capacity, the difference in target soil moisture deficit was only 10 mm.



Refilling the soil profile:

- More and longer periods when leaching and nitrous oxide emissions occur as soils are wet.
- Compaction likely.

Managing a soil water deficit:

- Reduced drainage and leaching.
- Nitrous oxide emissions reduced.
- Less irrigation applied and more rainfall captured.

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IRRIGATION NEW ZEALAND

To work out your irrigation trigger point for maintaining a deficit, you need to know:

- The size of your soil's "bucket" (available water holding capacity) – see below.
- The target soil moisture deficit for the crop.

To determine when and how much water to apply you need to know:

- The current soil water content – estimated from a soil water balance or measured using sensors.
- How much your irrigation equipment applies – check your actual amounts.
- Rainfall – recent or expected – check your local forecasts.
- Current and expected plant water use (ET).

SETTING THE IRRIGATION TRIGGER POINT:

Firstly, find out what the **available water holding** capacity is for your soil types. This is the amount of water that can be extracted by the plant. It varies according to soil type and plant rooting depth.

The best way of getting this information is to have the soils described and mapped on your property. Soil maps and soil water holding capacity information for a wide range of soil types are also provided by S-Map (http://smap.landcareresearch.co.nz).

If you have a site specific soil description then you can estimate the soil water-holding capacity using the Soil Profile Builder tool (www.irrigationnz.co.nz).

Target soil water deficit is the **trigger point** for irrigation. It should be set at or above the **stress point**, below which plant production is lost, and ideally this should be set so that irrigation does not fully re-fill the soil. The stress point will depend on the soil's available water holding capacity, crop and stage of crop development. Deeper-rooting crops will be able to extract more water from the profile than shallow-rooted crops. In mid-summer building up a water deficit may not be practical as the irrigation system may not have the capacity to keep up with high plant water use.

A rule of thumb often used for a range of pasture and crops is that the trigger point is about half the available water content in the rootzone. Note that for annual crops the rooting depth will increase as the plant develops.

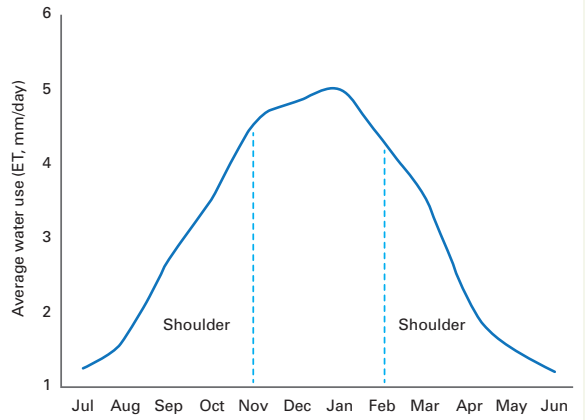
Soil water content can be measured directly using soil moisture sensors, or estimated from a soil water balance.

For more information on crop water requirements, stress points and soil water monitoring see the Foundation for Arable Research publication "Irrigation Management for Cropping - A Grower's Guide" and the DairyNZ "Guide to good irrigation".

Shallow stony soils have limited water storage potential —"small buckets".

In most cases, modern irrigators have the potential to apply amounts that can still leave the "bucket" partially full, even in a shallow stony soil.

This Eyre soil has about 70 mm of available water in the top 60 cm, or 35 mm of readily available water. Applying 15 to 20 mm of irrigation and triggering at or about 25 to 35 mm gives plenty of "headroom" to capture rainfall events.



Average daily water use for pasture at Lincoln. Water use for annual crops will depend on stage of development.

Further information:

Soil mapping and soil water:
S-Map (http://smap.landcareresearch.co.nz).
Contact a pedologist through Landcare Research or Soil Scientists at Waikato, Massey or Lincoln Universities.

Estimating available soil water content:
Soil texture and water and Determining soil texture fact sheets. Irrigation New Zealand. (www.irrigationnz.co.nz).
Soil Profile Builder tool. Plant & Food Research and Irrigation New Zealand. (www.irrigationnz.co.nz).

Crop water requirements:
Irrigation Management for Cropping - A Grower's Guide. Foundation for Arable Research. (www.far.org.nz/mm_uploads/Iss_04_Irrigation.pdf)
Guide to good irrigation. DairyNZ. (www.dairynz.co.nz/publications/environment/guide-to-good-irrigation-part-1/)

Soil water monitoring:
There are a range of soil water sensors available. Check with Irrigation New Zealand for guidance. There are also a range of irrigation scheduling services available.