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Calculating water use indices to benchmark water use efficiency

Irrigation benchmarking can be used to gauge water use efficiency (WUE) performance. Irrigation benchmarks can be calculated at a field or whole farm scale and used for comparisons over seasons, regions or with industry averages to enable continuous improvement in water use efficiency.

The two key WUE performance indicators used for irrigation benchmarking are Irrigation Water Use Index (IWUI) and Gross Production Water Use Index (GPWUI). Both indices can be calculated at a farm or field scale.

Irrigation Water Use Index (IWUI)
IWUI relates total production only to the amount of irrigation water used. It does not include rainfall and therefore is only useful for comparing between nearby fields or farms in the same season. It should not be used to compare fields or farms over significant distances or between seasons, where there would be large differences in the amount of rainfall received.

Farm scale:

$$IWUI_{farm} = \frac{Total\ production\ for\ farm\ (bales)}{Irrigation\ water\ supplied\ to\ farm\ (ML)}$$

Field scale:

$$IWUI_{field} = \frac{Total\ production\ for\ field\ (bales)}{Irrigation\ water\ supplied\ to\ field\ (ML)}$$

For example:

- Whole farm produced 450 bales (b)
  Used 350 ML irrigation water
  $IWUI_{farm}$ = 450/350 = 1.3 b/ML
- Yield from field = 80 bales
  Applied 50 ML irrigation water
  $IWUI_{field}$ = 80/50 = 1.6 b/ML

The field has done better than the whole farm: produced more lint per ML of irrigation water. This may be due to factors such as rainfall timing, disease, pests or nutrition.

Gross Production Water Use Index (GPWUI)
The best water use index for comparing bales per ML between farms, regions and seasons is the Gross Production Water Use Index ($GPWUI_{farm}$). This relates total production (bales) to the total amount of water used, from all sources including irrigation water, rainfall (total or effective) and soil moisture.

Farm scale:

$$GPWUI_{farm} = \frac{Total\ production\ for\ farm\ (bales)}{Total\ water\ used\ on\ farm\ (ML)}$$

Field scale:

$$GPWUI_{field} = \frac{Total\ production\ for\ field\ (bales)}{Total\ water\ applied\ to\ field\ (ML)}$$

Total water must include:

- water pumped from bores and/or rivers
- the amount of water used from storages
- water harvested during the season
- rainfall (effective or total rainfall – but must state which one you use)
- soil moisture used during the season

For example:

- Whole farm produced 450 bales (b)
  Used 490 ML total water (irrigation water, effective rainfall & soil moisture used)
  $GPWUI_{farm,\ effective}$ = 450/490 = 0.9 b/ML
- Yield from field = 80 bales
  Used 100 ML total water (irrigation water, effective rainfall & soil moisture used)
  $GPWUI_{field,\ effective}$ = 80 / 100 = 0.8 b/ML

Therefore the field was unable to produce as much yield (0.8 b/ML) as the whole farm average (0.9 b/ML) for each ML of total water input.

What farm data is required for measuring bales per megalitre

The inputs used to calculate these irrigation water use indices are usually easily extracted from farm records held with each grower. The records that need to be kept include:

1. Yields – from ginning reports

2. Water inputs:
   - Water diverted – the licensed metered water. The readings from your meters installed on your river pumps or bores.
   - Volume of land surface diversions which includes stormwater runoff from fields, water harvested during storms or floods from the farm or adjacent land and rainfall on storages. If not metered it can be estimated from pumping records and storage volume records.
   - Storage Volumes – storages should be recently surveyed and ideally have a calibrated gauge board or electronic storage meter installed. The more frequently storage levels are monitored the better harvested volumes can be determined.
   - Starting and ending soil moisture deficit – this can be measured in actual mm if soil moisture monitoring equipment has been calibrated or if soil cores are taken at the start and end of the season and volumetric water content determined. In most cases it is estimated from uncalibrated soil moisture data based on the soils full point and refill point.
   - On-farm rainfall – preferably from rain gauges located close to the cropping area.

Web-based tools currently available to collate information to benchmark WUE include the commercially available WaterTrack Rapid™ and WaterTrack Divider™ developed by Aquatech Consulting, Narrabri.

The significance of these tools is that the calculations of water use indices are standardised and defined. WaterTrack Rapid™ not only calculates a range of water use indices, but also calculates crop water use and provides an estimate of on-farm water losses. WaterTrack Divider™ divides total losses into storage, channel and field losses.

Gross Returns per ML ($/ML)

If you know your $IWUI_{farm}$ or $IWUI_{field}$ (refer to page one of this fact sheet), this index can be simply multiplied by the price per bale which you received for your cotton to give Gross Return IWUI ($/ML), where ML is the amount of irrigation water only.

For example:

- $IWUI_{farm}$ = 1.3 b/ML
  Price per bales = $450
  1.3 x 450 = $585/ML

Likewise, $GPWUI_{farm}$ or $GPWUI_{field}$ (refer to page one of this fact sheet) can also be multiplied by price per bale to give Gross Return WUI ($/ML), where ML is the total water used at the farm or field level including soil moisture, rainfall (total or effective) and irrigation water.

For example:

- $GPWUI_{farm,\ effective}$ = 0.9 b/ML
  Price per bales = $450
  0.9 x 450 = $405

For more information:

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Information for this fact sheet has been sourced from:

- Waterpak 2013 www.cottoninfo.com.au/publications/waterpak