Irrigation Efficiency

Key points
Water use and efficient irrigation are becoming increasingly important as the water resource is under growing pressure and as energy costs escalate.
- The Code of Practice for Irrigation Evaluation establishes standard practices for on-site assessment of irrigation systems and their management to help optimise efficiency.
- A number of key performance indicators are determined, providing growers with information about evenness and depth of application, amount of applied water usefully stored in the soil, and areas where improvements can be made.
- When adequate farm information is available, seasonal irrigation efficiency and adequacy, and regulatory compliance can be assessed.
- Of 16 spray irrigators tested, potential application efficiencies varied from 35% to 90%.
- Improvements in irrigation efficiency of over 10% were achievable with many irrigators and at $3.00/mm/ha this could save over $60/ha/year.

Introduction
Irrigation accounts for 70% of all water use in New Zealand and contributes $920 million to GDP.

Low irrigation efficiency has negative impacts on farm profitability and the environment. Poorly performing irrigation systems and poor scheduling are major causes of low efficiency and waste of water and energy.

Evaluations identify causes of poor performance and opportunities for improvement. Evaluations can be conducted to test that new systems perform to expected standards, or to monitor performance of existing systems.

The irrigation industry must manage water in a responsible manner and recognise the rights of other users. The Code assists irrigators to demonstrate good practices that minimise environmental impacts. Irrigation evaluations are valuable additions to environmental quality assurance systems which are required for marketing some products.

What is an irrigation evaluation?
On-site evaluations utilise selected measurements to describe irrigation system performance, evaluate management and identify causes of poor performance. Actual measurements are used wherever possible.

A typical evaluation consists of visual inspections of system components (pumps, filters etc) and catch can testing to determine distribution uniformity and potential application efficiency.

Where information is available, seasonal irrigation efficiency and adequacy are calculated and energy efficiency and regulatory compliance assessed.

The information needed for an evaluation includes:
- General information on property, climate, soil types and in particular depth.
- Information on the water supply – source, quality, consents and flows and filtration.
- Irrigation system information – system layout, age, condition, operating pressure, flows etc.
- Irrigation management – monitoring, irrigation interval and duration and application depth.

Conducting an evaluation includes:
- Observation of crop growth patterns, crop interference, root depth, soil conditions and an estimate of water holding capacity.
- Visual checks of pumps, filters, sprinkler patterns, wear and installation.
- Noting degrees of surface ponding, leaks and off target application during an irrigation event.
- Testing flow and pressure at set points and monitoring power usage.
- Measuring application rate and uniformity with catch cans.
- For moving systems, monitoring machine speeds and assessing wheel track conditions.

Seasonal irrigation efficiency evaluation requires:
- Daily or weekly records of irrigation and rain.
- Daily or weekly records of PET & crop factors.
- Soil water holding capacity and management allowable deficits for the crop.
Indicators of water use efficiency
There are many indicators of water use efficiency describing different aspects of irrigation. Those adopted by the Code for Irrigation Evaluation include:
- Crop irrigation demand and allowable deficit
- Irrigation return interval
- Application uniformity rate and depth and system capacity
- Efficiency of application, distribution and headworks
- Energy use per millimetre of water applied
- Environmental impacts – extraction, drainage

Other indicators include:
- Supply reliability
- Capital and operating costs
- Labour requirements

Evaluation reporting

System evaluations
Standard irrigation evaluation reports cover measured system performance, estimated potential application efficiency and opportunities for improvement. The irrigation system performance is tested on site under the prevailing crop and weather conditions.

The primary focus is to determine distribution uniformity, applied depth and application rates and the causes of non-uniformity. Uniformity is critical for irrigation to be efficient (not wasteful) and effective (adequately waters plants).

Seasonal management evaluations
Where available, system management records can be analysed to determine the efficiency and effectiveness of irrigation scheduling on a seasonal basis. This requires knowledge of soil water characteristics, the timing and amount of irrigation and rainfall and crop water use.

Soil moisture budgets are compiled to trace water supply and use, comparing total irrigation and rainfall with estimated crop evapo-transpiration. Other factors considered include soil water holding capacity, soil moisture at the start and end of the season and system distribution uniformity.

Efficiency versus effectiveness
Irrigation efficiency compares the amount of water taken to the amount stored in the root zone to meet plant needs. Potential application efficiency and seasonal irrigation efficiency are examples.

Irrigation effectiveness considers whether sufficient irrigation is applied to meet crop needs on a given proportion of the paddock. Potential soil moisture deficit is a good indicator of effectiveness. Combined with crop drought response factors it can be used to estimate the amount and value of crop loss caused by under watering.

Only very uniform systems with correct application rates, depths and scheduling can be both very efficient and effective.

Irrigation efficiency test results
Twenty irrigation systems were evaluated using the Code for Irrigation Evaluation and IRRIG8™ software. System types included drip-line, multiple spray lines, booms, linear moves and centre pivots.

Very few systems had no significant issues reducing efficiency. Causes included poor design, overly spaced sprinklers, neglected maintenance, poor components and inappropriate scheduling and operation.

Distribution uniformity varied considerably with corresponding variation in potential application efficiency (PAE). The best system’s PAE was 90% (excellent) with several being 84 – 88% (very good). With excellent scheduling, these systems will adequately meet the needs of most of the field with only about 10% water wastage.

The worst spray system measured (Towable Multiple Sprays) had PAE as low as 35% (very poor). This means only 35% of water applied to the field is likely to be useful to crops.

Correction of obvious system failures raised the performance levels from 35% to 60% by correcting pressure and using more uniform sprinklers.

Although best spray irrigation distribution uniformity was achieved by centre pivot (0.90) and linear move (0.88) irrigators, poor pivots were also found (0.67 and 0.75). Low sprinkler numbers, insufficient pressure, and problems with dry-wheel packs adversely affected performance.

Many systems, particularly fixed and rotating booms, had excessive application rates. Surface ponding and field run-off were clearly evident. Speeding up machines and decreasing applied depths would reduce this wastage of water and power.

In many cases improved scheduling would greatly increase efficiency and give very significant savings.

Irrigators are commonly applying excessive depths with insufficient frequency. This both wastes water through excess drainage, and penalises yield though water logging followed by drought stress.

For more information, including sample reports, see www.pagebloomer.co.nz/irrigation1.html

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