Digging Into Irrigation Efficiency on the North Coast

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- This study presents findings from irrigation assessments conducted across 28 intensive horticultural operations on the NSW North Coast, focusing on distribution uniformity (DU) performance in both soil-based (12) and substrate-based systems (16)
- Distribution uniformity averaged 73% & 88% for soil-grown and substrate systems, respectively
- Only 8% of soil grown and 56% of substrate systems achieved optimum DU of 90% (optimum industry standard)
- Critical issues identified included many blocked and partially blocked emitters and lateral and sub-main drainage post system shut-off leading to poor DU
- Incorrect valve pressures, erosion and insufficient maintenance regimes were also found
- An Excel spreadsheet toolkit was developed to standardise DU calculations and support industry-wide performance improvement

Intensive horticulture production continues to expand on the NSW North Coast with transition of soil grown blueberries to substrate-grown systems and substantial expansion of substrate grown cucumbers and Rubus (raspberries and blackberries) under protected cropping systems. The horticulture industry's emphatic hype on precision agriculture technologies, such as sophisticated fertigation systems and climate monitoring tools, can lead to a dangerous disconnect if foundational principles of irrigation and drainage are not in place. While these technologies can offer significant benefits, site-specific monitoring becomes meaningless when irrigation output across the block varies substantially (> 100% in many situations).

Poor uniformity creates cascading problems: some plants receive excess water and nutrients while others are stressed, leading to uneven crop development and reduced productivity. More critically, poor DU results in economic waste - growers must over-irrigate entire blocks to ensure stressed plants receive minimum requirements, resulting in significant water, energy, and nutrient losses.

Irrigation and drainage assessments were conducted by Local Land Services (LLS) and NSW Department of Primary Industries and Regional Development (DPIRD) staff on 12 soil-grown blueberry, 6 substrate grown blueberry/Rubus and 10 substrate grown cucumber systems. Comprehensive evaluation included flow rate measurements, pressure monitoring at different hydraulically challenged locations, drainage and environmental assessment, and component condition evaluation. Irrigation and drainage management practices were also recorded from an interview survey.

A standardised Excel spreadsheet toolkit was developed to enable consistent data collection and assist with DU calculation across operators.

Distribution uniformity (DU) is the ability of the irrigation system to deliver water and fertiliser evenly to all plants in the block. DU is a key metric for irrigation system efficiency, and systems should achieve DU >90%, meaning all emitter outputs are near equal. A system that delivers high DU will improve water and fertiliser application and increase fruit yield and quality.

Findings

There were performance differences between soil-based and substrate-based systems. While substrate-based systems achieved an average DU of 88%, soil-based berry systems consistently demonstrated poor performance with an average DU of just 73%. Key factors influencing system performance included maintenance protocols, topographical challenges, emitter condition, system design and installation, erosion and source water quality. Across all systems assessed, source water was often observed to contain high algal growth and presence of aquatic weeds. Regular source water testing was not a common practice. However, filtration was generally found to be sufficient for water delivery. Farmer capacity on flushing protocols was lacking, with questions on maintenance regimes the most common query received during the interview stage of the assessment on majority of farms.

The following findings are organised by growing system type to highlight the distinct operational challenges and performance characteristics observed.

Soil-Based System Performance

Despite use of pressure compensating drip tube, soil-based berry systems consistently demonstrated poor DU, with 11 of the 12 below the optimum standard of >90%.

The soil-grown blueberry systems assessed were generally designed to run down the slope with downhill irrigation supply. The systems assessed were typically on steep or very steep terrain, with Land and Soil Capability (LSC) between 5 – 7.

Blocks on steep terrain often suffered excessive post-system shut off drainage with some emitters discharging flow for over 10 minutes after system shut off, with bottom-of-slope emitters receiving up to 200% of designed irrigation volumes. This occurred when sub-mains drained through laterals to low-elevation emitters as seen in Figure 2. For example, emitters designed for 1.6 L/hr delivered over 3.0 L/hr including drainage.

On all sites assessed, it was observed that erosion was impeding trafficability and/or source water quality with likely flow on production effects. Erosion was most significant on steep sloping, down-the-grade blocks with minimal groundcover in the interrow. Erosion was less pronounced on blocks that ran diagonally across the grade.

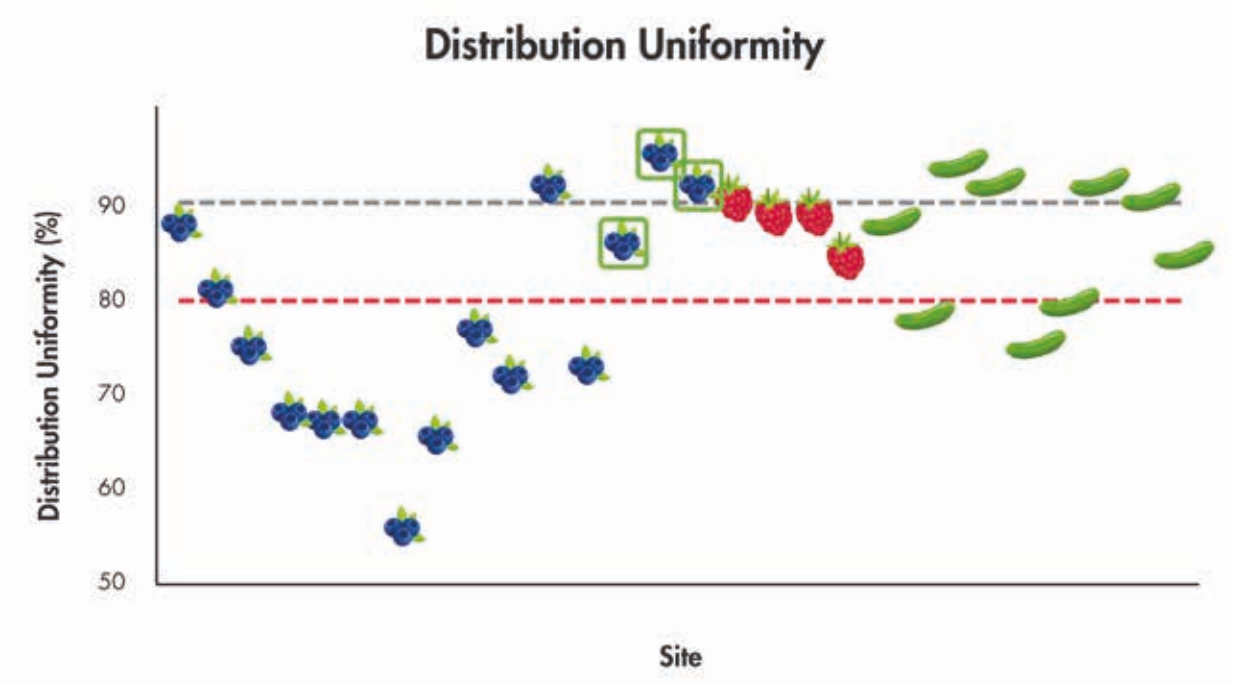

Figure 1. Distribution Uniformity (DU) of soil grown blueberries, substrate blueberries (green box), raspberries and cucumbers

Figure 2. Soil berry systems assessed were typically on steep or very steep terrain
Photo credit: North Coast Local Land Services

Figure 3. Erosion occurring in the interrow
Photo credit: North Coast Local Land Services

Blocked and partially blocked emitters were endemic across soil-based systems. Many blocked emitters were excluded from DU calculations, meaning the actual block uniformity was worse than calculated values. The prevalence of these blocked emitters indicated that systematic maintenance protocols were not implemented or were ineffective.

The position and condition of makeshift flushing 'taps' at the end of laterals indicated flushing was not regular. Flushing valves on mains and submains were not common, indicating that maintenance was not considered at the design and installation phase of many systems. This was supported by laterals regularly exhibiting tied or knotted ends, rather than adequate flushing hardware. Flow rates of some PC emitters were above design, potentially due to algae build up impeding diaphragm function, further indication of poor maintenance regime.

Valve operating pressures exceeding 400-500 kPa were documented across multiple operations, causing fitting failures and poor uniformity. Conversely, some blocks experienced inadequate pressure due to system leaks, poor design and on one farm a poor performing pump (likely impeller issues), resulting in emitter flows well below design specifications and inadequate flow for maintenance.

Substrate System Performance

Substrate-based systems had an average individual block DU of 88% (with a range of 75-95%). The presence of dripper line non leakage (DNL) valves in substrate-based systems enabled pulsed irrigation with short charge-up time and eliminated the excessive post system shut off drainage issues seen in soil-grown systems. However, due to the need for leaching, erosion and drainage issues were present between and at the end of rows on Rubus systems without adequate control measures.

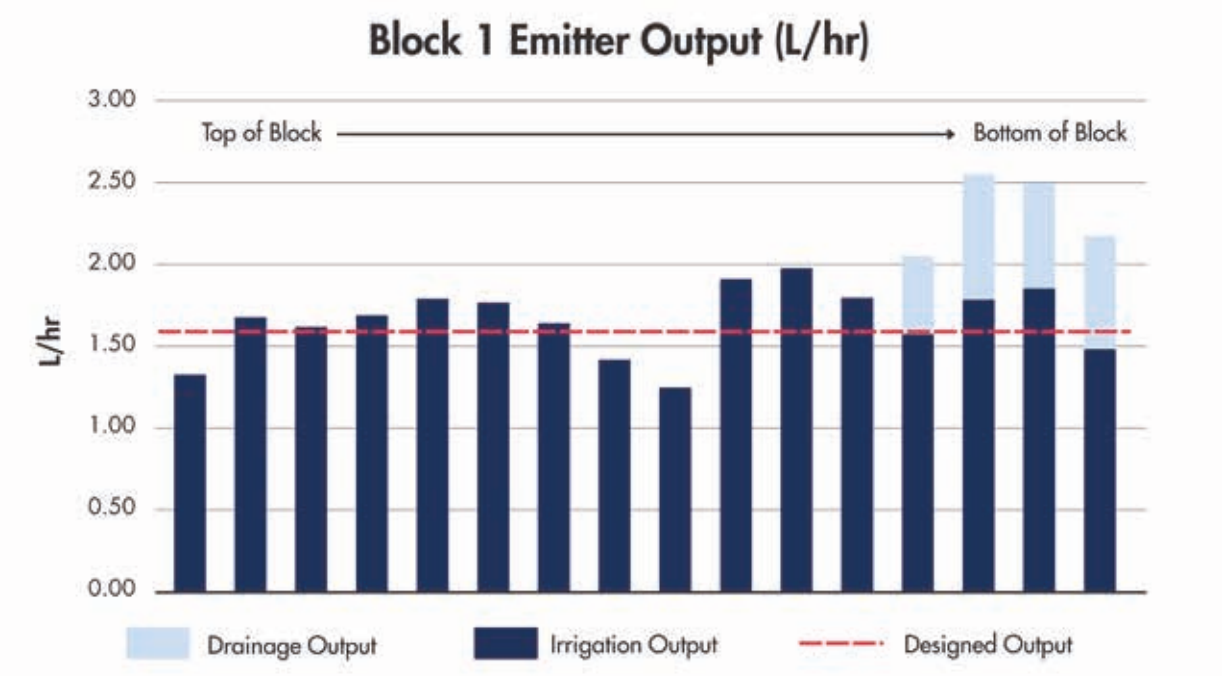

Figure 4. Example of emitter flow rates

Solutions and Recommendations

Although many systems' performance suffered from inherent design flaws and poor maintenance, installing low-cost retrofit options and improving the maintenance flushing regime will overcome many issues in the short term. In the long term, a focus on repairing and preventing erosion should be a priority for all soil-grown systems assessed to ensure the viability of future operations on these farms.

Such options include:

- Implementation of systematic flushing protocols following industry maintenance guidelines
- Installation of DNL valves on sub-mains and laterals to eliminate post-shutdown drainage
- Valve pressure adjustment to maintain optimal operating ranges
- Increasing ground cover on farm to >90%, with a particular focus on decreasing herbicide spray width at weed mat interface in interrow and integrating slashing
- Installation of drainage controls are required to assist with surface water management as well as irrigation drain water run off

Excel spreadsheet Toolkit

As part of the assessments, Excel spreadsheet toolkit templates for soil and substrate systems were developed to standardise data collection and automate DU calculations, eliminating calculation errors.

The Excel spreadsheet toolkit is available for distribution to irrigation practitioners and includes DU calculation templates and data collection protocols.

The toolkit can be accessed by contacting North Coast Local Land Services at Admin.northcoast@lls.nsw.gov.au

Or you can find your local LLS Office at www.lls.nsw.gov.au/i-want-to/contact-my-local-office/north-coast-local-offices

Conclusions

The assessments demonstrated that irrigation system maintenance is an overlooked practice on farm. Substrate-based systems generally adhered to fundamental design principles, however, soil-based systems generally had inherent design flaws, although low-cost retrofit options do exist.

Key findings include:

1. **Distribution uniformity is critical** - Soil-based systems consistently fall below the industry standard DU of >90%
2. **Common issues are preventable** - Most problems stem from poor maintenance and design oversights
3. **Low-cost solutions exist** - DNL valves, pressure regulation, and flushing protocols can dramatically improve performance
4. **Industry support needed** – Training and upskilling are essential for widespread industry improvement at the farmer and advisor level

Acknowledgements

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