Irrigation Check-Up Programme 2017

An assessment of irrigation efficiency to promote responsible water use

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Irrigation Check-Up Programme 2017

An assessment of irrigation efficiency to promote responsible water use

May 2018

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Executive summary

Irrigation efficiency is becoming increasingly important from a regional water management perspective. From an individual users perspective, it can mean time and cost savings and pave the way for more strategic water use, beneficially impacting on environment, production, and profitability.

Hawke's Bay Regional Council is directing more focus towards responsible water use, which includes irrigation efficiency. Rather than simply taking an information based approach, the Irrigation Check-Up programme was established to be a hands on practical way of promoting efficient irrigation. The voluntary programme ran over the 2017/18 summer and is currently under consideration for following seasons. Irrigation NZ were key consultants for this programme.

Summer students worked with participants to check their irrigation systems and provide them with useful feedback and results. A survey was also used to find out about on farm water management practices and scheduling. Throughout the programme 41 properties were assessed in total, which equated to 51 irrigation systems. This covered a range of land use and irrigation system types. Results can only be considered indicative as the sample was not randomly chosen.

Efficiency test results

The programme involved a basic irrigation check on up to two irrigation systems for each participant/ manager. A bucket test assessed Distribution Uniformity (DU) or Emitter Uniformity (EU) which checks how evenly the water is being applied and also compared target application depth to an actual application depth.

Of the irrigation systems tested the uniformity results ranged from very poor at 0.33 to excellent at 0.95 (≥0.8 is accepted as the performance benchmark for uniformity). Some of the other key findings included:

- Of the 51 irrigation systems tested, 49% were performing with an irrigation uniformity of 0.8 or above and required little or no corrective actions, 24% of systems required some attention to improve the performance, and the remaining 27% required significant work.
- Drip/ Micro systems performed reasonably well with 59% of them achieving an EU of 0.8 or higher, however, for Pivot and Hard hose systems only 37% achieved this benchmark. The programme helped to address information gaps in the importance of irrigation uniformity.
- When comparing target irrigation depth to that actually applied, 35% of systems achieved a 'Test Passed', however, a similar percentage did not know their target depth (33%). Further investigation showed that all were Drip/ Micro, and for most of this group irrigation scheduling is based on one or a combination of soil moisture metering, monitoring software and/or consultant advice. Many also consider irrigation in terms of litres per hour or litres per plant. It is still critical however for these participants to be aware of their actual application depth (mm) so they can more effectively follow through with consultancy advice and combine this with weather forecast information. For some, the programme helped to inform participants of the application depth.
- A combination of soil moisture meters, monitoring software and or a consultant to assist with irrigation scheduling was adopted by 67% of the participants. Of this group 73% said that one or more of their scheduling methods were used to schedule irrigation 'every time'. Whereas 21% said that it was used 'most times' and 6% said that the information was only used 'sometimes'.
- The largest take up of consultancy services for scheduling irrigation was by Orchardists. Of the 26% of participants using consultants to schedule irrigation all bar one were for orchards. Of the 33% using 'other' methods to schedule irrigation many were using methods such as 'digging a hole'.
- The programme results showed that the age of infrastructure can be linked to the uniformity of a system. Reassuringly new systems were all performing as they should, however, it was noted the older systems as they approached the 10 year mark, there was a drop-off in performance indicating

the need for better maintenance. For systems 15 years or older, maintenance requirement increased further and some could be reaching the end of their serviceable life.

- Although most participants were put at ease and were confident to answer accurately, there was concern from the students that some responses were the 'right' answer, rather than reflecting reality
- It must be noted that by participating in the programme all participants have shown they are aware of the importance of efficient irrigation. Understanding how well a given system is working is the first step in working towards efficient water use.

Observations

The students recorded observations for the blocks they assessed and reported these back to participants. While this assessment is subjective and records what the students observed in the areas they were working, it did not seek to identify all potential issues.

Overall, some of the issues observed appeared to be similar, irrespective of a high or low DU or EU test result, however, the extent of the issues appeared to be more significant in the poorer performing systems e.g. leaks became bigger/ increased in number for drip micro, or the presence of leaks in pivots became noticeable in the poorer systems.

The same issues observed could be caused by a number of different factors and could be a symptom of an underlying problem, e.g. water quality, pressure, well performance, pump performance etc. Basic field observations are recorded in Table 1-1.

Table 1-1: Field Observations of irrigation system issues.

Performance Level	Drip/Micro	Pivot/Hard hose
Main issues observed for systems with 0.8 and above DU results	• Mostly minor leaks, some tending to significant • Some sprinkler heads detached/missing • One to a few had disconnected lines, end plugs missing or lateral ends not closed off properly • Some end of row drippers not working • A range of sprinkler types • Slight algal growth • Variable dripper outputs • Some sprinklers not spinning	• Individual to a few sprinklers not spinning or spinning slowly • Individual to a few sprinklers dribbling • Individual to a few sprinklers partially blocked • Variable spray patterns • Minor chance of wind drift issues
Main issues observed (in addition to those above) for Drip/micro with below 0.8 DU results	• Significant leaks more prevalent • Many drippers not working throughout blocks • Many drippers emitting obviously (visually) more flow than others • Water quality issues causing blockages e.g. iron flakes, algae • Disconnected lines, end plugs missing or lateral ends not closed off properly • A significant range of sprinkler/dripper types within a block	• Many sprinklers not working • Many worn sprinklers • Sizable leaks between spans • Faulty end guns • Nozzles missing • Wind drift • Some ponding • A lack of run overlap

General programme outcomes

From a general uptake and motivation perspective, some participants were initially cautious of the programme. They were possibly concerned about the outcomes if they had poor results. Others who already suspected their irrigation system was not up to scratch, were keen to get their systems checked and find out how big the issue was. In some cases their system results helped the participant to prioritise repairs or push for system upgrades. For those with newer system this simply gave them reassurance that they were on the right track or highlighted if improvements were possible.

The most important aspect of the programme was whether the participants found the programme beneficial. The post programme survey revealed that there was a high level of satisfaction for those that responded. All respondents indicated both that they found their results data useful, and that they would participate in any future programme (12 respondents).

It was noted that all of the post programme respondents that had 'room for improvement' results were either 'working towards improving their irrigation system', or 'working towards replacing their irrigation system' (7/12 respondents). The remainder had irrigation systems that were operating efficiently so no immediate action was required.

Irrigation Check Up programme future

Increasing awareness of efficient water use and changing approach to irrigation (if required) were the key objectives of the programme. There is a change in Hawke's Bay about how water is being managed e.g. the TANK Plan Change. Recently have we really become more aware of the pressures on the water resource. It will take time for this understanding to result in behaviour change, but it is happening. Support and tools need to be in place to assist the necessary behavioural shift. The Irrigation Efficiency Programme can assist with this.

In the establishment phase of this programme, data security was a concern by some industry groups. Protection mechanisms were put in place to prevent individuals' data from being used out of context or for compliance purposes in the form of a participant agreement. The programme was established to promote irrigation efficiency without fear of repercussion. All participants are commended for participating and voluntarily taking steps towards efficient water use.

Council is currently considering whether to run this programme again. In order to do this, it is critical that 'good will' is maintained. The overall goal is for all irrigation water users to use water responsibly and effectively. This programme shows that it can be done effectively, in a positive way.

Overall the message and understanding of water efficiency was well received, and further work with consent holders would be beneficial for maximising the regions water resources.

Recommendations

For HBRC to continue working collaboratively with IrrigationNZ, industry bodies and irrigation consent holders to promote irrigation efficiency through:

- A Good Farming Practice implementation programme that includes workshops and demonstration days.
- Future Farm Environmental Management Plan requirements to encourage Good Farming Practice
- Continuing the Irrigation Check Up programme (or similar) to assist consent holders with the uptake of Good Farming Practice.

1 Programme Process

The Irrigation Check-Up pilot programme offered irrigation water users the opportunity to check if their system operated the way it was initially intended. Hawke's Bay Regional Council (HBRC) established the pilot Irrigation Check Up programme to provide irrigators with useful data about their irrigation system efficiency. The programme also offered some direction for participants to optimise their system, if necessary.

Irrigation NZ was contracted to supply technical support in the form of training, and irrigation system trouble shooting. The pilot for Hawke's Bay was run over a 3 month period (November 2017 – February 2018) and based on a similar programme run in Canterbury, although, there were differences due to the range of land uses and irrigation system types. The programme offered to check up to 2 irrigation systems per manager, to accommodate larger corporate organisations. Weather suitability caused some scheduling disruption (wind as well as rain), but despite this 41 properties in total were assessed which equated to 51 irrigation system.

Programme process

1. **Efficiency check**
   The programme involved a basic efficiency check (bucket test) to see if water was being distributed evenly throughout the irrigation system (uniformity), target application depth was also compared with actual application depth. For Pivots and Hard hose systems uniformity is referred to as the Distribution uniformity (DU) and Emitter uniformity (EU) for dripline and micro systems.

2. **Programme survey**
   Participants were required to answer a survey on how they manage their irrigation. This covered aspects such as irrigation system information and irrigation management. This helped build a picture of what practices are being adopted and how they are used. Understanding this can help target future irrigation efficiency programmes appropriately.

3. **Irrigation system results report**
   The efficiency check data was processed and a results letter was provided to each participant. This detailed EU or DU results, actual application depth in comparison with what they believed the system was applying (if known) and some field observations.

4. **Drop in sessions/feedback**
   Drop in sessions were set up for participants to find out more about their test results. The take up for this was minimal (it was a busy time of year for participants), whereas some chose to go directly to their service provider or intended on replacing their system so there was no need to attend. Drop in sessions were not the best format for discussing results and will be revised for future programmes.

5. **Post-programme survey**
   A post-programme survey was also conducted to find out if participants found their results useful, how they used their results and whether they would participate again.

2 Testing Methods

The systems tested throughout the programme included: Pivots, Travelling Guns (Hard hose), Linear Booms, Rotorainers, K-Line (set-pod-system), Micro-Dripline, Micro-Sprinkler, Rotorainer and K-Line.
There were two methods for data collection and assessing irrigation performance depending on irrigation type:

- **Check-It Bucket Test App** used for: Pivots, Linears, Travelling Guns, Travelling Booms, K-Line and Rotorainers - referred to as 'Pivot and Hard hose' (In more detailed irrigation type assessments K-Line and Rotorainer have been considered as 'other').
- **Irrig8lite software** used for: Dripline or micro - referred to as 'Drip/Micro'

Both are free to download, with the Check-It Bucket Test App from the app stores and Irrig8Lite from Irrigation NZ's website. Both contain instructions for data collection and produce reports for the users.
It must be noted that this methodology is for a basic efficiency check and if issues are found, further investigation is recommended. Also, any efficiency check results can only be considered valid for the time it was tested. Results are indicative only, as there are many factors that influence how efficient a system is working – those factors may or may not be influencing at the time of the test.

Pivot and Hard hose testing

The efficiency 'bucket test' for these system types involves setting buckets out either parallel or perpendicular to the irrigator, at spacing specified by the App (see Figure 2-1 below). Information such as length of pivot or boom, target application and system operating pressure is required. Once the irrigator has completely passed over the buckets the water volumes can then be collected and entered into the 'App'. From this the Distribution uniformity (DU) is calculated to show how efficiently the system is operating. The DU results can be interpreted as per
Table 2-1.

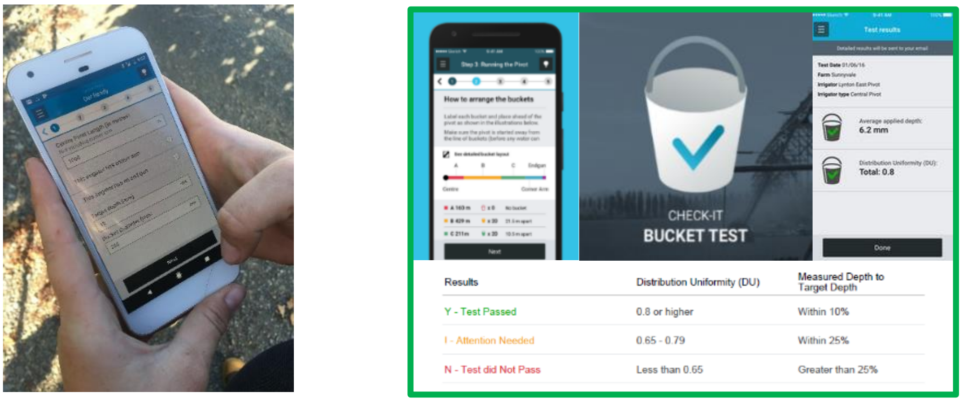


Figure 2-1: Example of the Check-It Bucket Test App.

Table 2-1: How to interpret Bucket Test App Distribution Uniformity results.

Efficiency DU Result	Interpretation	Bucket Test App. Category
0.8 (80%) or higher	Considered efficient	"Test Passed"
0.65 - 0.79	Considered as needing minor improvements	"Attention Needed"
lower than 0.65	Considered as needing major improvements	"Test did not pass"

Testing these systems using the Bucket Test App is user friendly and relatively straight forward process. This is something that irrigators could pick up and use themselves, and something Hawke's Bay Regional Council can actively endorse. The Irrigation Check Up programme however, offered additional assistance to trouble shoot the cause of low efficiency results which is not provided for in the App.

Drip/Micro

Dripline or Micro-Sprinklers were tested using the 'Irrig8lite' software as these systems are not included in the Bucket Test App. These systems were usually orchards or vineyards and require a different style of testing in the field.

For each system (that is, all blocks operated by one pump set-up) 3 different blocks are chosen to represent the whole system. The block closest and furthest from the pump and one in the middle are assessed for emitter uniformity (EU) and target depth versus actually applied irrigation depth (mm). Emitter uniformity is a measure of how even the water is applied from each dripper tested. This shows how the blocks perform in relation to each test position along the mainline. Figure 2-2 below shows the bucket layout for each block, with the triangles representing the buckets within the block, which covers 4 lateral rows at the beginning, middle and end of the block. Water is collected at each bucket location. The system is tested mid operation to ensure water is collected at the usual operating pressure.

Figure 2-2: Example of which blocks to efficiency test.

Irrigation systems with poor water quality or filtration tend to have sediment build up in lines. This sediment most commonly builds up in the blocks furthest from the pump. This methodology theoretically captures the 'cleanest' and 'dirtiest' blocks. The results from Irrig8lite can be interpreted as per Table 2-2.

Table 2-2: How to interpret Irrig8lite results

Efficiency EU Result	Interpretation
EU>0.9	Uniformity is very good – the system is performing very well. You can be confident of this result
0.9-0.8	Uniformity is good – performance better than average. You can be confident of this result
0.8-0.7	Uniformity is fair – performance could still be improved. The result is likely to be a good indication of system performance.
0.7-0.6	Uniformity is poor – system should be investigated. Results may be less reliable – redo the testing to check.
EU<0.6	Uniformity is unacceptable – system must be investigated. Results are less reliable – redo the testing to check.

The risk with testing systems with this methodology is the potential to unintentionally introduce bias. Although emitters (sprinkler/dripper) are chosen ‘randomly’, the student chose which one to test. Potentially if an emitter appeared to not be working properly or water is tracking along the pipe the tester might choose one that does appear to be working properly. This could be averted in future by having some rules around which dripper/sprinkler to test.

Irrig8lite software although functional, is relatively old technology which had some compatibility issues with the latest Word and Excel programmes. Water users can easily replicate the water collection methodology, however, the old software could be a barrier for irrigators to undertake efficiency checks without assistance.

For the purposes of this report the Emitter uniformity results categories (i.e. pass/did not pass) have been aligned with the Check-It Bucket Test App categories.

3 General Results

Throughout the programme 41 properties were assessed in total, which equated to 51 irrigation systems. Results can only be considered indicative as the sample was not randomly chosen. All assessments have been based on the number of systems assessed (51) unless stated otherwise.

Land Use Types

The project assessed irrigation efficiency, covering a wide variety of land use types and production systems in the Hawke's Bay Region. The land uses assessed were dominated by pipfruit, viticulture, sheep and beef and vegetable cropping. The distribution of each is shown below (Figure 3-1).

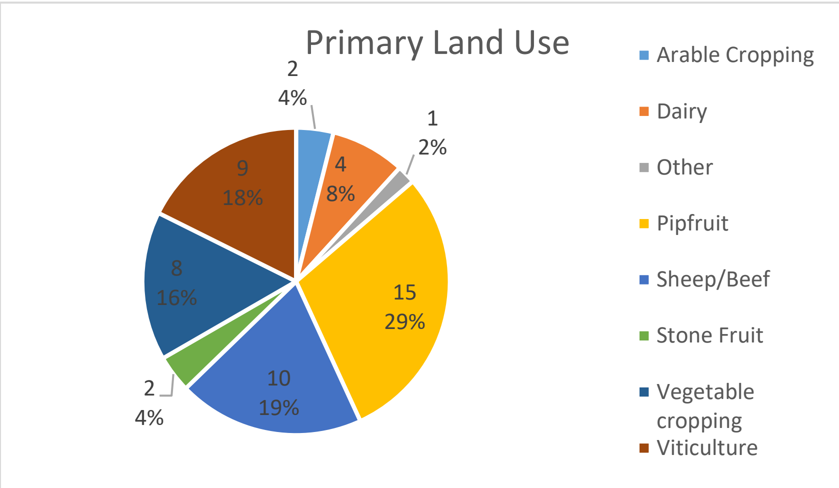


Figure 3-1: Primary Land Use of Properties that Participated in the Irrigation Check Up Programme.

Irrigation System Type

There was a reasonable spread of irrigation system types assessed. Pivots and Drip accounted for 33% and 31% respectively. Drip and Micro combined accounted for 53% of the system types, which were mostly apple orchards and vineyards. Hard hoses were a relatively small proportion as were 'Other' which included K-Line and Rotorainer systems.

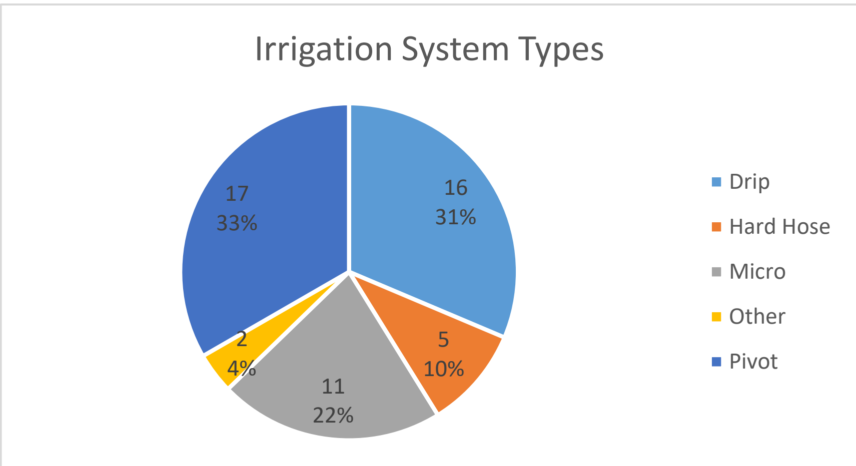


Figure 3-2: Irrigation System Types Checked in the Irrigation Check-Up Programme 2017/18.

4 Results: Distribution and Emitter Uniformity

Distribution uniformity (DU) or **Emitter uniformity (EU)** is a measure of how evenly the irrigation system spreads water along its wetted length. DU measures the uniformity of pivot and hard hose irrigators over the wetted area. EU measures the evenness of flow between individual emitters in drip/micro systems.

The aim of irrigation is to ensure most of the crop is adequately watered. The industry standard is that 7/8ths of a crop should receive the minimum amount of water needed. If a system has a low DU or EU this means that a large proportion of crop will end up overwatered or under watered. This can cause production losses, environmental issues as well as wasted energy costs by pumping more water than needed.

It is important to understand the potential level of efficiency that can be achieved by a given system type. Irrigation New Zealand have assessed where most irrigation systems fit in relation to the industry standard (80% efficiency or higher) (Figure 4-1).

Some Regional Resource Management Plans now specify an irrigation system efficiency percentage. However, it is noted that some system types will struggle to reach higher uniformities such as Rotorainers and travelling guns due to their design and susceptibly to wind.

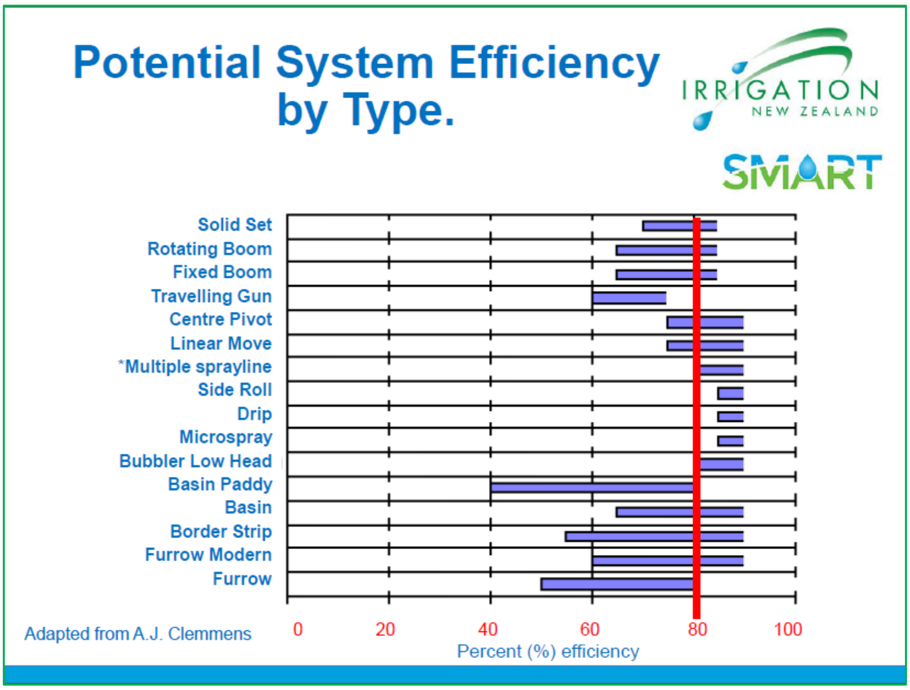


Figure 4-1: Irrigation NZ - Potential System Efficiency by Type. *Note many of these system types ('side roll', 'bubbler low head' and below) are generally not present in Hawke's Bay.*

Uniformity Results All Systems

The uniformity for all system types showed 49% achieved a 'Test Passed' DU/EU result of 0.80 or higher. While 24% achieved an 'Attention Needed' result with the remainder of 27% showing a 'Poor' result (Figure 4-2).

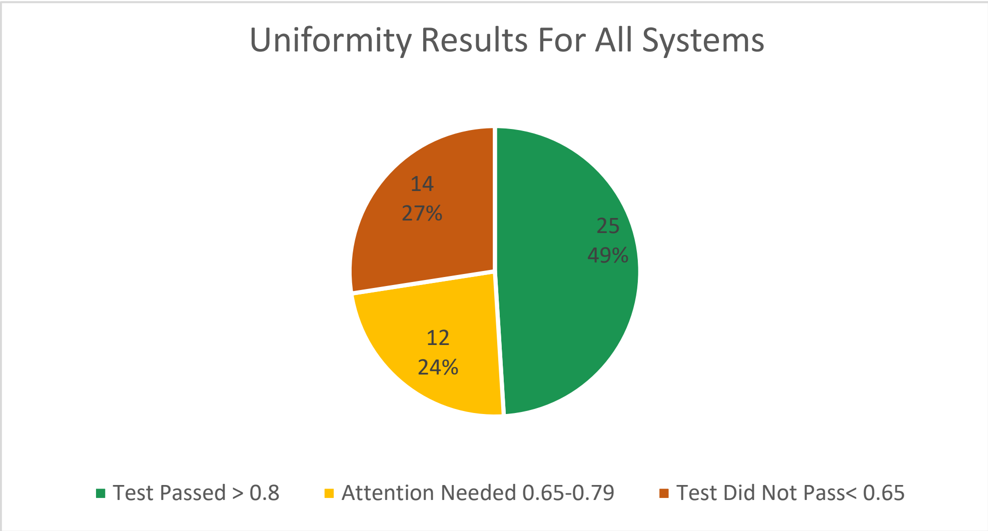


Figure 4-2: Emitter Uniformity (EU) and Distribution Uniformity (DU) Results for All Systems (51). Using an average of the drip micro blocks for each system & converted to Check It Bucket Test App categories.

Within the different irrigation types Drip systems had the highest percentage of 'Test Passed' results at 63%. This was followed by Micro at 55% and Pivot systems at 53% (Figure 4-3). Hard hose systems struggled with 71% achieving a 'did not pass' category.

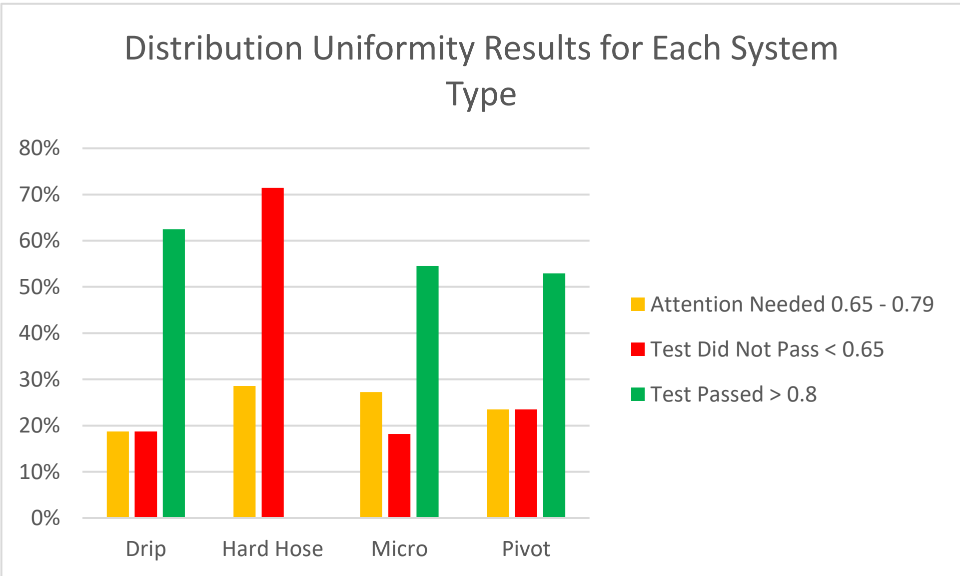


Figure 4-3: Distribution Uniformity (DU & EU) Results for all System Types (Percentage; 51). Using an average of the drip micro blocks for each system & converted to Check It Bucket Test App categories.

EU Results: Drip/Micro System

It is reassuring to see that of the drip micro systems tested, well over half were operating at a 'Test Passed' level (59%). Whereas 19% were at a 'Test did not Pass' level (
Figure 4-4). The majority of those that did not pass were older systems that appeared to be at the end of their life or had been subject to ad hoc maintenance over the years. *Note: Drip/Micro results have been calculated from an average of the individual block results for each property. The result categories have also been converted from Irrig8lite to the Check-It Bucket Test categories' for analysis purposes.*

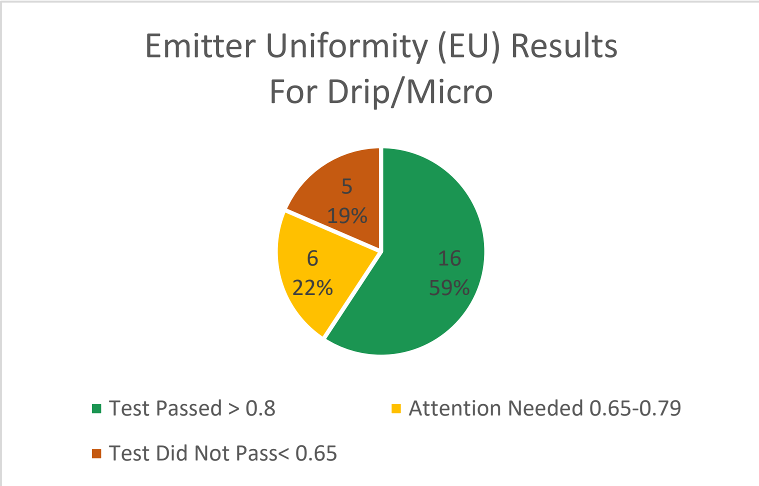


Figure 4-4: Emitter Uniformity (EU) Results for Drip/Micro (27).

DU Results: Pivot and Hard hose

The DU results for Pivot and Hard hose irrigators showed that 63% needed attention or did not pass (Figure 4-5). Guns had poor performance with no gun type system achieving a DU of 0.8 or higher (Figure 4-3). This was largely due to wind susceptibility and operational issues. The pivots that were poor performing tended to have issues with pressure or aging infrastructure resulting in worn nozzles and failed pressure reducing valves (PRVs). *Note: 'Other' systems have been categorised as Hard hose.*

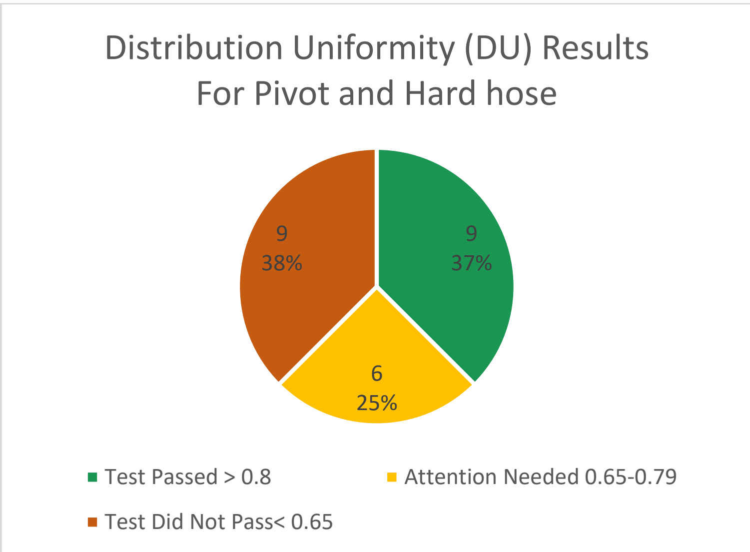


Figure 4-5: Distribution Uniformity (DU) Results for Pivot and Hard hose irrigators (24). Includes irrigators categorised as 'other'.

5 Results: Application Depth

Irrigation Application Depth (mm) is also a key water use efficiency consideration. It is important to know the application depth to understand how much water is being applied for a given irrigation period. Systems with a good DU or EU may still not apply what the grower thinks they are. If this isn't known there is a risk of over or under irrigating potentially causing problems with crop yield losses, runoff and/or drainage losses from the soil profile. These issues can have environmental and/or economic impacts.

Applied Depth vs Target Depth: All Systems

This part of the assessment checked if the actual irrigation application depth (mm) was the same as the participant believed it to be. Though overall 35% of systems achieved a 'Test Passed', nearly the same proportion did not know their target depth (Figure 5-1) (discussed further below).

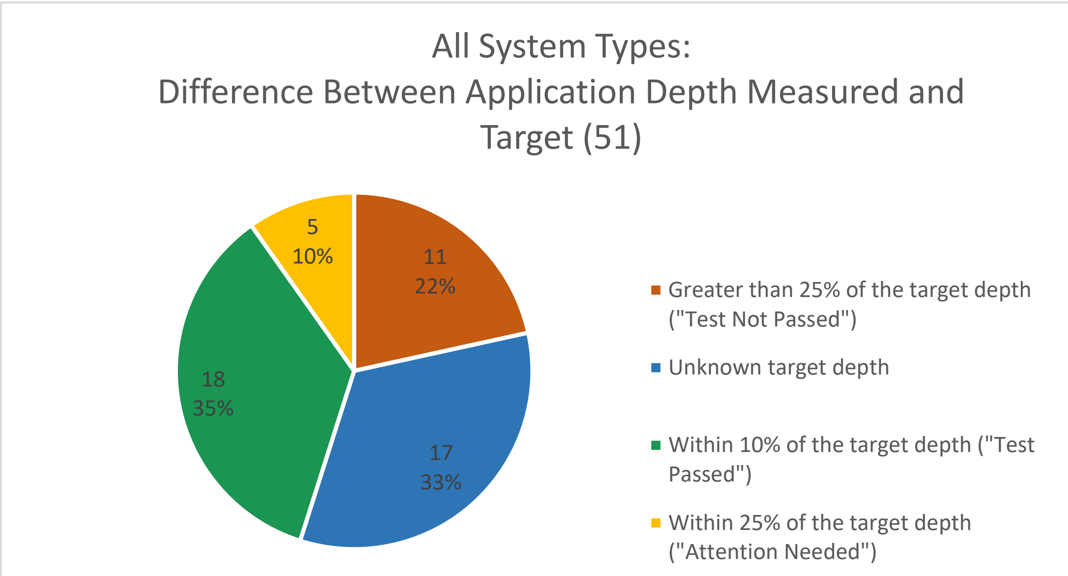


Figure 5-1: All System Types: percentage difference between Application Depth Measured vs Target (51). Using an average of the drip micro blocks for each system.

Applied Depth vs Target Depth: Drip/Micro

All of the 'Unknown' target depths had Drip/Micro systems (Figure 5-2). When this data is assessed further it shows that for most of this group, irrigation scheduling is based on one or a combination of soil moisture metering, monitoring software and/or consultant advice (Figure 5-3). Also some participants may not have been able to answer the survey question as they work in litres per hour or litres per plant. The survey questions can be altered to address should the programme run again.

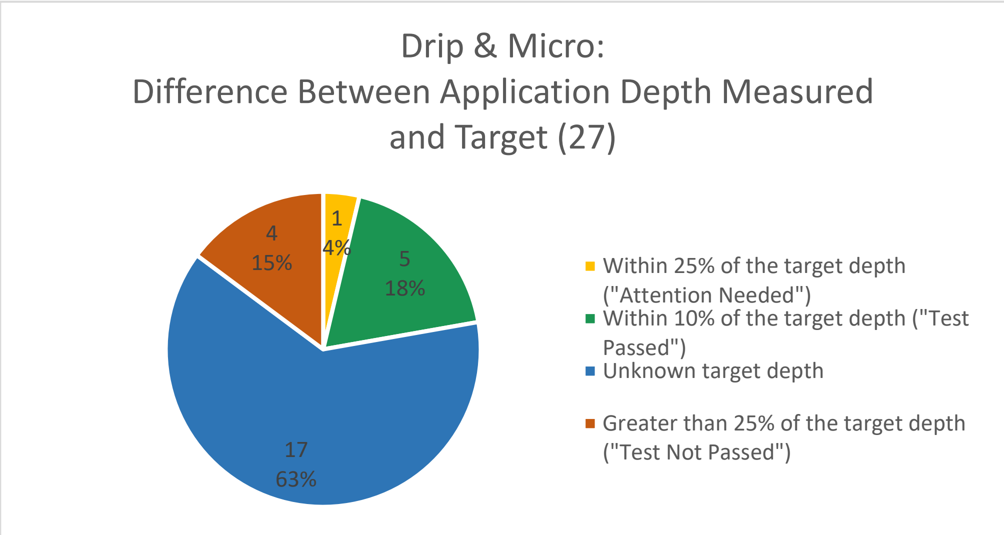


Figure 5-2: Drip & Micro: Percentage difference between Application Depth Measured Vs Target (27). Using an average of the drip micro blocks tested per system.

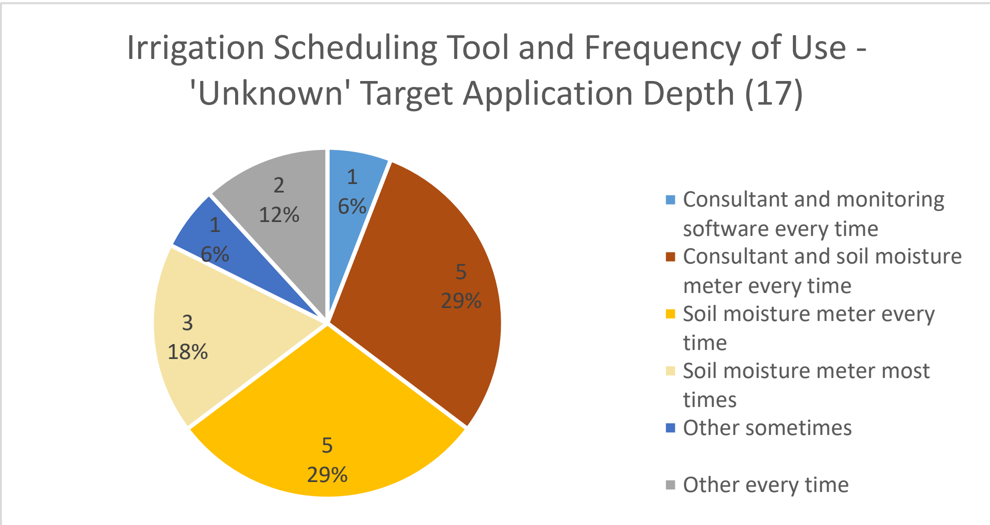


Figure 5-3: Irrigation Scheduling Tool and Frequency of Use For Those with 'Unknown' Target Application Depth (17).

The programme did not ask what triggered participants to turn off their irrigation, however this information is equally important. Consultants can often advise clients to irrigate a set depth of water. This is difficult if you don't know what the system is applying. Some participants said they irrigated based on time, however this was not always translated to a depth. If soil moisture monitoring is used in conjunction with consultancy services, over irrigation should be picked up retrospectively and managed over time i.e. future irrigation events can be shortened to limit drainage losses.

The ideal situation would be for irrigators to know the rate of water application (mm/hr), have calibrated soil moisture monitoring or monitoring software and have sound advice on when to trigger irrigation and how much. Advice would also take into account soil moisture trigger points e.g. stress point, full point, saturation, water holding capacity, readily available water and infiltration rate.

For those that irrigate based on a volume per plant this also needs to be done with good knowledge of soil moisture trigger points to minimise drainage losses and/or unnecessary water use.

Applied Depth vs Target Depth: Pivot and Hard hose

Over half of the Pivot and Hard hose systems assessed had a ‘Test Passed’ result (
Figure 5-4). Irrigation applied rate (mm) (or depth per unit time) can be altered by changing the speed of the machine. Pivots and linear irrigators display the applied rate (mm) on the control panel screen. Therefore, all users of these systems were aware of their intended application rate. Basic efficiency testing such as this can identify if there has been an issue when the system was set up or if something has affected the machines calibration.

In some cases, a DU “pass” was achieved but application depth achieved an “Attention Needed” result. For pivots this means the machines speed is not calibrated correctly which affects the depth (mm) applied on the control panel. If this occurs for Hard hose guns or booms the speed settings on the machine need to be reviewed and adjusted accordingly.

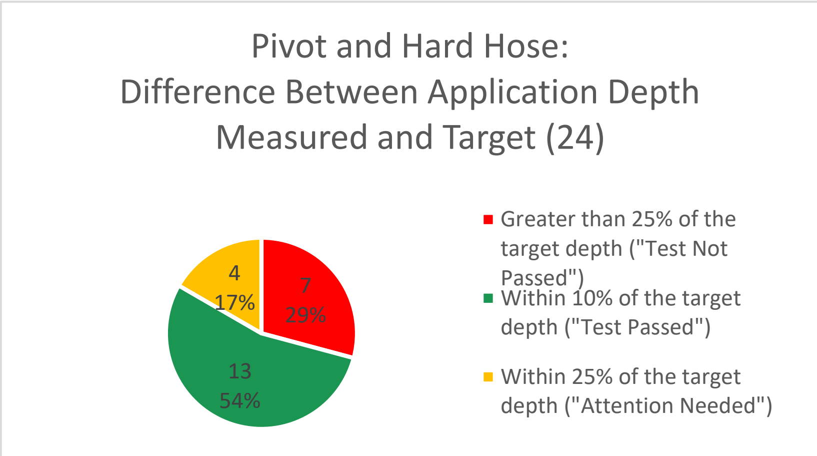


Figure 5-4: Pivot and Hard hose: Percentage difference between Application Depth Measured vs Target (24).

6 Results: Age of Infrastructure

The existing irrigation infrastructure in Hawke's Bay varies widely in age, although drip-micro systems are currently seeing a boom with almost a third of systems being installed within the last 5 years. This can be attributed to the horticultural boom triggering many orchardists to plant new varieties and/or lease land. With good maintenance a pivot irrigation system should last 20-30 years. The longevity of any irrigation system will depend on design, maintenance, and componentry. Of the systems assessed 52% are 10-years or older (Figure 6-1, Figure 6-2; Figure 6-3).

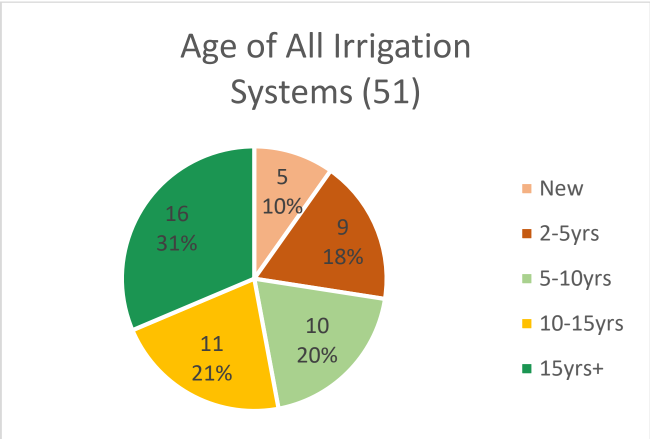


Figure 6-1: Age of All Irrigation Systems (51).

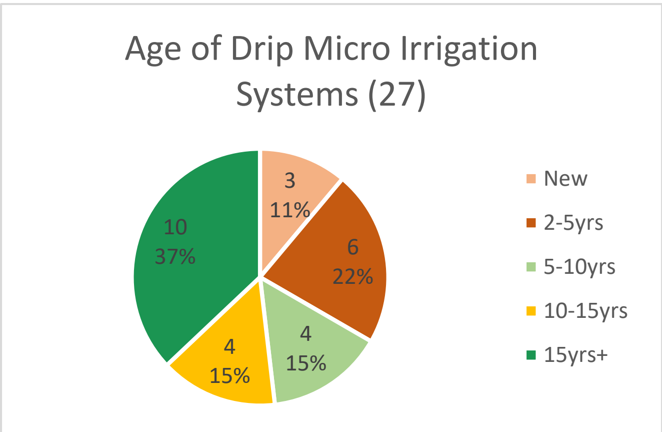


Figure 6-2: Age of Drip Micro Irrigation Systems (27).

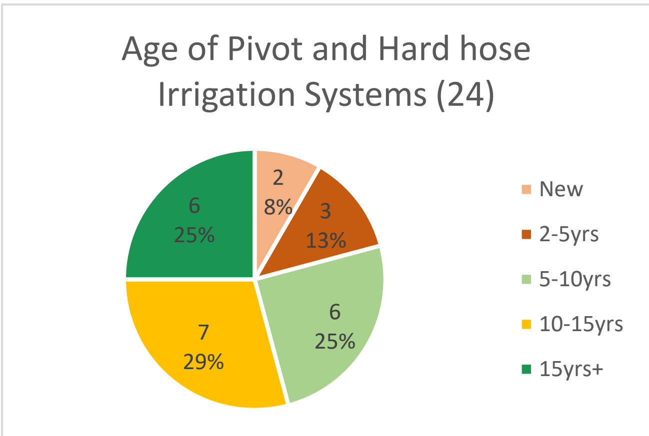


Figure 6-3: Age of Pivot & Hard hose Irrigation Systems (24).

By comparing the age of irrigation systems to the uniformity results, it shows a trend of performance declining as the systems age (Figure 6-4). This is seen through the decreased percentage of uniformity 'Test Passed' as we move from 'New' to '15years+', at the same time there is an increase in tests not passing. A similar trend can also be seen when comparing system age with applied depth results, with a dramatic increase in 'Test not Passed' results as systems age (Figure 6-5).

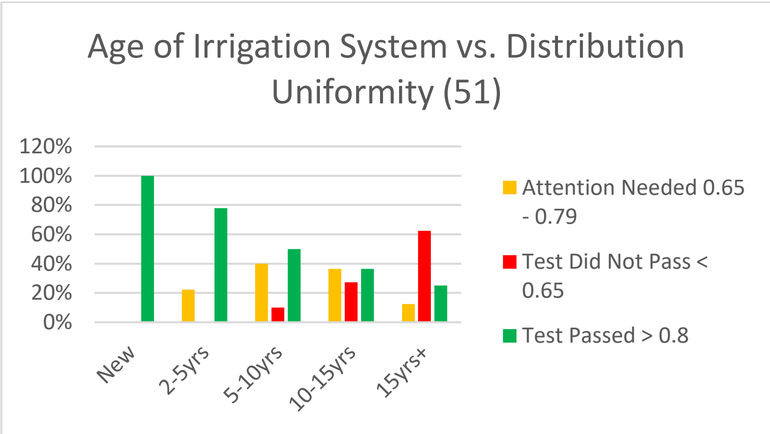


Figure 6-4: Age of Irrigation System vs. Distribution Uniformity (51).

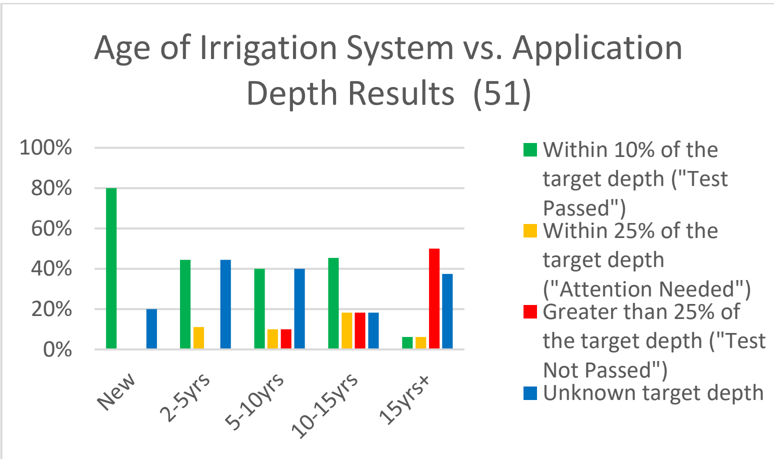


Figure 6-5: Age of Irrigation System vs. Application Depth Results (51).

Unsurprisingly this suggests that as irrigation systems get older and are subject to greater wear and tear, the demand on system maintenance increases. Alternatively, these older systems would have been the 'early adopters' and without having comparative testing it is difficult to know what their starting DU/EU, or application depth was at design and installation.

It is reassuring that the newer system installations show a 100% 'Test Passed' result. This is a good indication that new irrigation design and installation is of a standard that can apply water efficiently. This pass rate is still high in 2-5year old systems but does begin to decline after this.

From a regional water management perspective there is increasing pressure on the regions water resources. As older irrigation systems are replaced with newer systems with advanced technology, this will provide an opportunity for better collective water management.

7 Results: Irrigation Scheduling Methods

Soil moisture assessment is a key part of irrigation scheduling and good management practice. This technology gives farmers and orchardists a tool to help them decide when to irrigate and how much water to apply. The survey asked what technology or systems were in place to make decisions on irrigation scheduling. *Note Irrigation scheduling is also discussed under 'Results: Application Depth' specifically for those with an unknown target depth.*

Of the systems assessed, 67% said that they used soil moisture sensors, monitoring software and/or consultants to make irrigation scheduling decisions (Figure 7-1). Consultants were used by 26%, some of which used a combination of methods. Most of these participants had Drip/Micro systems.

It is notable that 33% use 'other' methods to schedule their irrigation. Further analysis of this group show that all except 3 of these have Pivot and Hard hose systems and many of them simply 'dig a hole' and a few use a water balance.

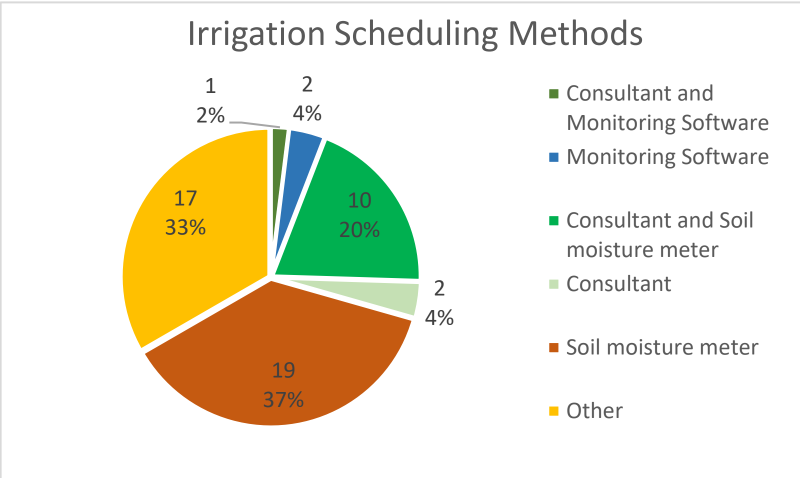


Figure 7-1: Irrigation Scheduling Methods Used (51).

For those that use soil moisture sensors, monitoring software and/or consultants to schedule their irrigation (34), the survey looked at the frequency of their use (Figure 7-2). Of this group 73% said that one or more of their scheduling methods were used to schedule irrigation 'every time'. Whereas 21% said that it was used 'most times' and 6% said that the information was only used 'sometimes'.

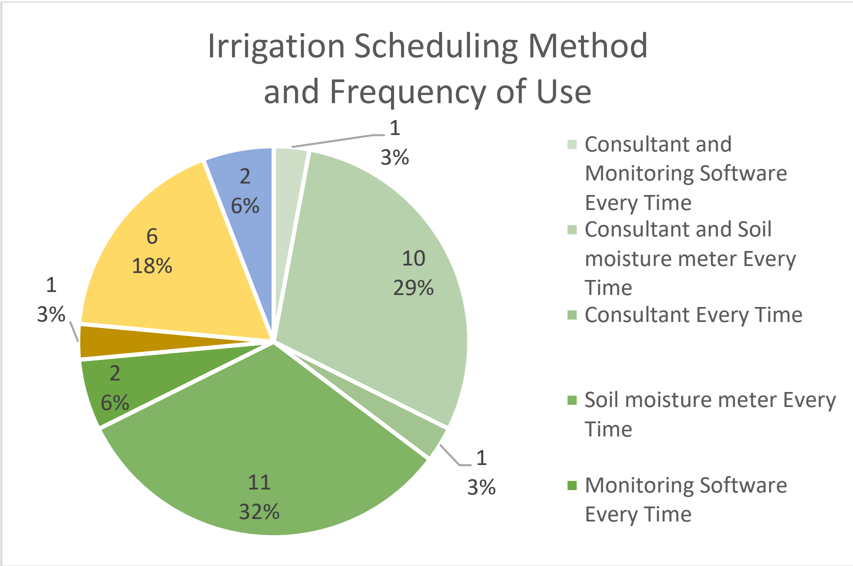


Figure 7-2: Irrigation Scheduling Method and Frequency of Use (34).
'Other' scheduling methods excluded.

Participants were also asked what prevented them from using some methods or technologies to schedule their irrigation. Some of the reasons included previous tools failing, lack of knowledge of how to make the most of the technology, cost and time.

8 Results: Field Observations

The students also recorded basic observations for the blocks they assessed and reported these back to participants. This assessment is subjective and only records what the students observed in the areas they were working. The programme did not seek to investigate this or develop an exhaustive list of system issues. Descriptors may also vary between systems or person recording. Should the programme continue more focus will be given to field observations which will allow for more analysis and will give more weighting to the results.

From what was recorded, the issues observed appeared to be similar irrespective of a high or low uniformity (EU or DU) result. However, the extent of the issues appeared to be more significant in the poorer performing systems. For example, the language changes for drip/micro from minor leaks to significant leaks. For pivots the language changes from one or two sprinklers not working in a span, to many sprinklers in many spans. An indicative list of observations is provided in Table 8-1.

Wind also affected a number of tests for hard hose systems and pivots. Both are susceptible to wind due to their large throw above crop canopies.

Table 8-1: Field Observations of irrigation system issues.

Performance Level	Drip/Micro	Pivot and Hard hose
Main issues observed for systems with 0.8 and above DU results	• Mostly minor leaks, some tending to significant • Some sprinkler heads detached/missing • One to a few had disconnected lines, end plugs missing or lateral ends not closed off properly • Some end of row drippers not working • A range of sprinkler types • Slight algal growth • Variable dripper outputs • Some Sprinklers not spinning	• Individual to a few Sprinklers not spinning or spinning slowly • Individual to a few sprinklers dribbling • Individual to a few sprinklers partially blocked • Variable spray patterns • Minor chance of wind drift issues
Main issues observed (in addition to those above) for Drip/micro with below 0.8 DU results	• Significant leaks more prevalent • Many drippers not working throughout blocks • Many drippers emitting obviously (visually) more flow than others • Water quality issues causing blockages e.g. iron flakes, algae • Disconnected lines, end plugs missing or lateral ends not closed off properly • A significant range of sprinkler/dripper types within a block	• Many sprinklers not working • Many Worn sprinklers • Sizable leaks between spans • Faulty end guns • Nozzles missing • Wind drift • Some ponding • A lack of run overlap

9 Conclusion

The programme offered a basic efficiency check using technology that is available for anyone to use, with the added benefit of trouble shooting system issues. Where issues were identified participants were advised to seek further assistance from their service provider or consultant for a more comprehensive irrigation system efficiency check. This programme did not seek to replace these services, but was intended to be complementary in an effort to promote efficient water use. The intention is for this programme to drive up the demand for such a service, so regular efficiency checks become common place. Long term it is anticipated that industry further establishes this service in the commercial space.

This programme was established as an initial pilot for the 2017/18 irrigation season. Overall the Irrigation Check Up programme was a positive and practical way to promote efficient water use. The post programme survey showed there was a high level of satisfaction for those that participated. By simply participating it showed they had some awareness of the importance of irrigation system efficiency.

Although many systems performed well for uniformity and application depth, there were still many that required work. Without this type of assessment it is difficult to establish the extent of system issues. Participants have indicated it was beneficial with many ‘working towards improving their irrigation system’ or ‘working towards replacing their irrigation system’ (post programme survey; 7/12).

The results from the programme highlighted some specific areas where future work needs to focus:

- Robust irrigation decision making (pivot and hard hose systems)
- Irrigation system management e.g. minimising wind effect (hard hose systems)
- Knowing irrigation application depths (drip/micro systems)
- Lower efficiency levels in some older irrigation systems

Regardless of their results, all participants should be commended for participating and voluntarily taking steps towards efficient water use. It is recommended that the programme continue and it is essential that good will toward participants is maintained to ensure successful uptake of any future programme.

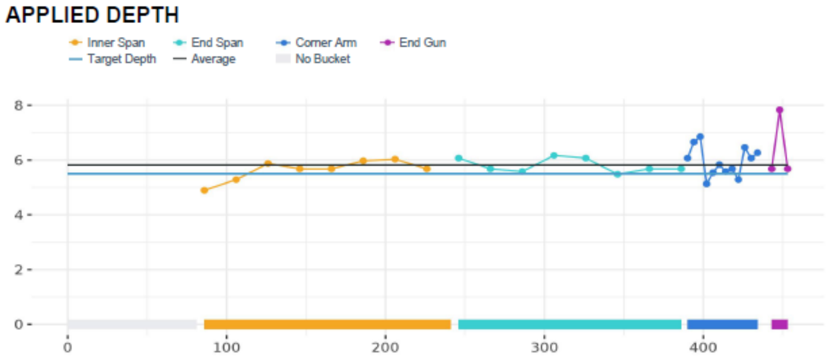
Recommendations

For HBRC to continue working collaboratively with IrrigationNZ, industry bodies and irrigation consent holders to promote irrigation efficiency through:

- A Good Farming Practice implementation programme that includes workshops and demonstration days.
- Future Farm Environmental Management Plan requirements to include Good Farming Practice
- Continuing the Irrigation Check Up programme (or similar) to assist consent holders with the uptake of Good Farming Practice.

Appendix A Case Study 1

Many systems showed good results for either uniformity or applied depth. The following results show a system that performed well for both these benchmarks. This is an example of a centre pivot with a high efficiency test result, under good management practice (GMP) and maintenance.



RESULTS

Sections	Distribution Uniformity (DU)		Applied Depth Average (mm)		Intensity (mm/hour)
Pivot + Corner Arm	**0.91**	Y	**5.82**	Y	
Pivot + Corner Arm + Endgun	0.91	Y	5.87	Y	
Pivot - Inner Span	0.90	Y	5.64	Y	
Pivot - End Span	0.95	Y	5.80	Y	47.35
Corner Arm	0.89	Y	5.95	Y	48.57
Endgun			6.40	!	

Irrigation system: 390m Centre Pivot with corner arm.
Age of system: 8 years
Target application depth: 5.5 mm
The centre pivot was tested in ideal conditions. The bucket test data, showed good performance across the machine with a distribution uniformity (DU) of 0.91 ('Test Passed'). The application depth was measured at 5.82mm which is within 10% of the target depth ('Test Passed').

Irrigation System Maintenance:
As irrigation systems get older, maintenance becomes increasingly important to maintain efficiency. On this system the farmer/operator prioritises maintenance by:

- Replacing failed equipment e.g. new pump installed.
- Comprehensive servicing of pivot every season (by preferred service provider)
- Weekly visual checks.

Management of irrigation involves:

- Reviewing soil moisture sensor results and report of recommendations.
- Irrigate at night.
- Forward planning for irrigation scheduling.
- Comprehensive pre-season maintenance checks by preferred service provider.

Appendix B Case Study 2

The following is a representative example of two blocks from different irrigation systems. The first is from an older irrigation system with a 'Poor' EU. The second is a newer system with a 'very good' EU. One factor contributing to the variance in results could be the age difference between the two blocks. The end result however, is a difference in maintenance requirements and system functionality.

Block 1

Irrigation system: Micro sprinkler in apples.
Age of system: 30 years
Target application depth: 5mm/hr.
The system was tested in ideal conditions at an application target depth of 5.0mm/hr. The applied depth was measured at 1.3mm/hr. This was greater than 25% of the target application, giving a "Test not Passed" result.

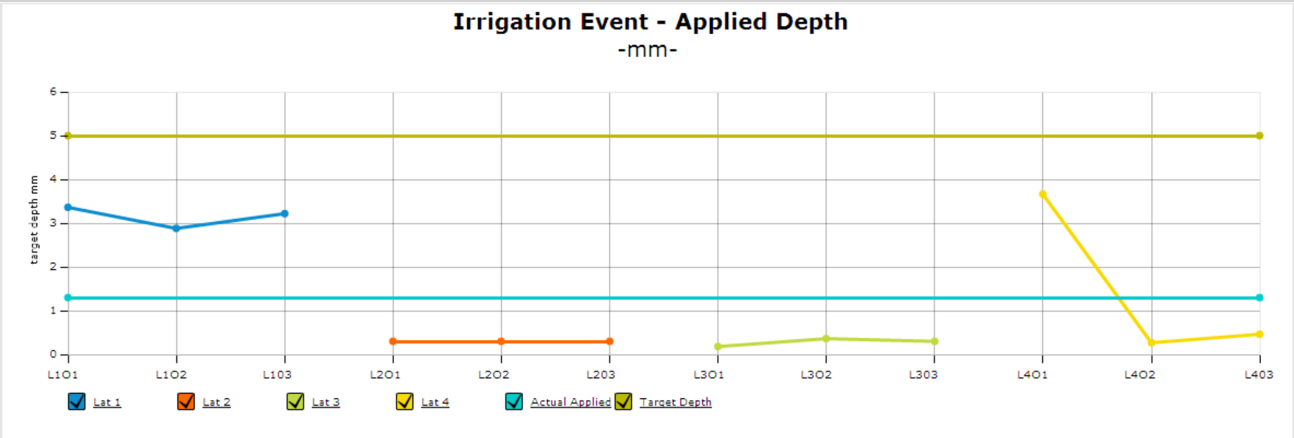
The irrigation uniformity for the block tested was measured at 0.19 (EU), which is considered an "Unacceptable" result by Irri8lite categories. This is equivalent to a "Test Did Not Pass" result when converted to the Bucket Test App.

Results

Test Date	Emission Uniformity EU	Emission Uniformity Performance	Average Emitter Flow -L/hr-	Actual Applied Depth -mm-	Target/Actual	Adjusted Runtime -hr-	Soil Applied Depth -mm-	Meter Flow - m3/hr-	Application Intensity -mm/h-
28/11/2017	0.19	UNACCEPTABLE	19.51	1.3	3.84	20.16	1.4	5.85	1.3

Irrigation Event - Applied Depth -

mm



There were a range of issues observed with this system. The most obvious was the variety of sprinkler heads, emitting different volumes and some with significant leaks. The orchard manager runs ongoing maintenance on the system e.g. fixing leaks and replacing sprinklers etc. Issues beyond this were not identified and could not be ruled out as contributing to the poor result. The participant acknowledged that the system is due for replacement and is working towards this.

Multiple sprinkler types within an orchard micro system is not uncommon. Often this can be as a result of retailers changing stocked items, stock temporarily unavailable, manufacturers ceasing production, changing to a cheaper option etc. Multiple emitter types with varying outputs and spray patterns should be avoided if possible.

Block 2

It is also important that we focus on systems with exceptionally good test results and find out more about what they do to achieve this. Below is an example of a newer drip micro system with good management practise (GMP) and maintenance. It is acknowledged that the excellent results are largely a product of good design as this is a relatively new installation. However, having good maintenance and management from the time of installation is also important.

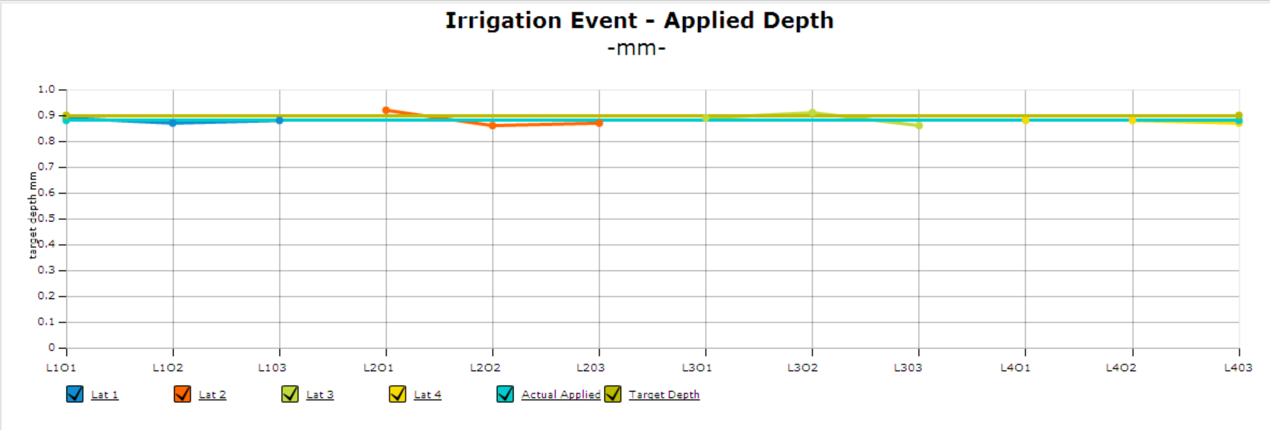
Irrigation system: Drip irrigation under grape vines.
Age of system: 3 years
Target application depth: 0.9mm/Hr.
The system was tested in ideal conditions with an application target depth of 0.9mm/hr. Data created from Irrig8lite shows the system was operating at a high level of efficiency. The system applied depth was 0.9mm/hr this was within 10% of the target depth ("Test Passed"). Overall the block tested was measured at 0.98 emitter uniformity, which is considered a "very good" result by Irrig8lite, or a "Test Pass" when converted to Check It Bucket Test categories.

Results

	Test Date	Emission Uniformity EU	Emission Uniformity Performance	Average Emitter Flow -L/hr-	Actual Applied Depth -mm-	Target/Actual	Adjusted Runtime -hr-	Soil Applied Depth -mm-	Meter Flow - m3/hr-	Application Intensity -mm/h-
Vineyard	10/01/2018	0.98	VERY GOOD	1.06	0.9	1.02	1.04	10.6	0.18	0.88

Irrigation Event - Applied Depth - Vineyard

mm



The right design is important to address site specific issues or prevent potential issues from arising e.g. potential water quality issues. This has been addressed by installing disk filters.

Regular maintenance from when the system is newly installed is important. It will help to identify and correct issues early and keep the system operating at optimum efficiency for as long as possible. For this irrigation system maintenance includes:

- General maintenance (fixing leaks etc.)
- Pre – season flushing of lines.
- Every 5 years a system acid flush is scheduled

Irrigation management is the next step toward efficient irrigation. For this property the system management involves:

- Physical/ manual checks with every application.
- Soil moisture sensors are installed and used.
- Consideration of weather forecasts, physical appearance of crop etc
- Use of Telemetry data to monitor correct application.
- Controller that provides data of flow rates and expected flows.

Appendix C Case Study 3

Often you cannot visually see system performance, this test highlights the importance of physically measuring via a bucket test to determine how well a system is actually working.

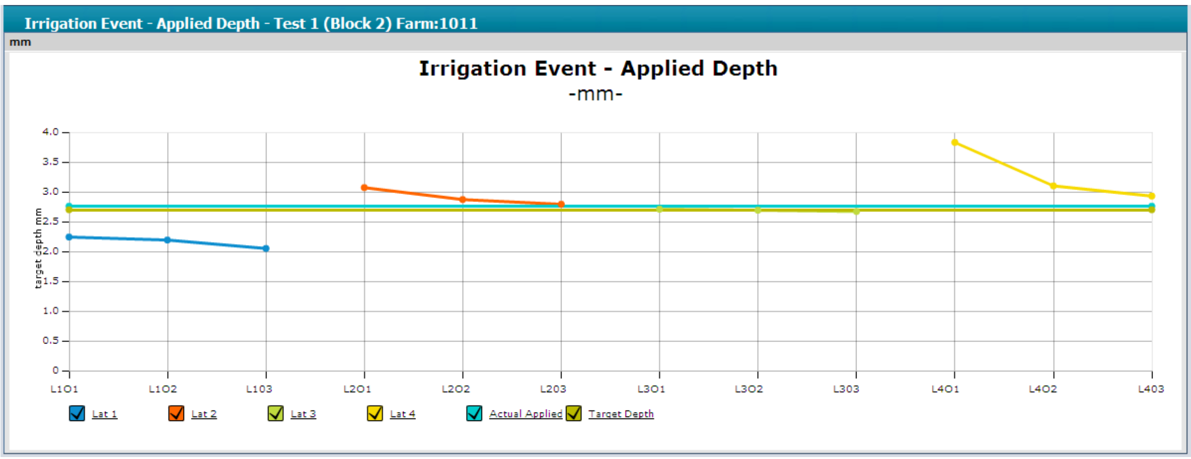
Irrigation system: Dripline under blueberries.
Age of system: 12 years
Intended target application: 2.7 mm/hr
Maintenance is a priority for the owner to ensure longevity of the system. The irrigation is checked for major leaks every time it runs, laterals are regularly flushed and filters are cleaned at regular intervals.

This system is a little different to normal with each row having two parallel driplines that operate at the same time. Because of this, two collection containers were placed parallel to each other to collect water. They were added together to establish the average emitter rate for that point as though there was only one dripper. The efficiency results are detailed in **Table C-1: Case Study 3: Irrigation efficiency test results**Table C-1.

Table C-1: Case Study 3: Irrigation efficiency test results

Site	Emitter Uniformity	Application	Result
Test 1 (closest block)	0.78	2.8 mm/hr	Fair
Test 2 (middle block)	0.95	2.9 mm/hr	Very good
Test 3 (furthest block)	0.82	2.9 mm/hr	Good

Figure C-1: Case Study 3: Irrig8lite results graph.



A drip or micro system should be performing in the range of 0.8-0.95 EU. The system performed well overall with Test 2 and Test 3 results within the expected range. Surprisingly, the first block (typically the best block) had ‘average’ results with an EU of 0.78 (“Fair”). The calculated target depth was correct at 2.8 mm/hr. Initially this looks alright but further analysis shows that there are inconsistencies with the results.

The raw data helps to decipher what is going on within the block (Table C-2). It was found that this block had dripline with two different emitter rates installed, which was not visually obvious. Because of the mix of emitter rates, this caused variations in the collected volumes for each row, this resulted in the lower EU of 0.78. The applied depth is on target for the desired depth. However, from the graph you can see some of the under and over watering on laterals 1 and 4 (

Figure C-1).

Table C-2: Case Study 3: Raw Data Table for Block 2.

Lateral 1a	Lateral 1b	Lateral 2a	Lateral 2b	Lateral 3a	Lateral 3b	Lateral 4b	Lateral 4b
160ml	176ml	196ml	265ml	154ml	252ml	285ml	290ml
159ml	170ml	175ml	255ml	153ml	251ml	280ml	185ml
158ml	150ml	157ml	262ml	151ml	250ml	275ml	165ml

There is also an outlier on lateral 4b, this is likely caused by either, water tracking along the lateral from another dripper and being caught in the collection container, or during maintenance potentially a new length of lateral was inserted with the higher emitter rate. No matter the cause, the owner now plans to change the drip line to ensure uniform application throughout the block.

The testing shows that the good maintenance practices are ensuring the emitters perform as they should. However, the mixed emitter rates are having a profound effect on efficiency and applied depths, resulting in under and over application. This ultimately means an effect on both yield potential and likely fruit quality. Without having an efficiency test these inconsistencies within the irrigation system could not be identified or rectified.