IRRIGATION NEW ZEALAND
TECHNICAL & TRADE

CASE STUDY 2:
HAWKES BAY APPLE ORCHARD

Summary

The irrigation system on this apple orchard has been upgraded and expanded over time. Using the Irrigation Decision Support Package to assist with this process may have:

- avoided poor performance;
- avoided costs associated with fixing mistakes, and;
- resulted in more efficient water application (i.e. more production and/or less pumping).

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About this Property

This 21 ha apple orchard is located near Hastings, Hawke's Bay. The farm is irrigated using hand-shift spray lines. Irrigation water comes from a groundwater well and is distributed through aluminium pipes.

The majority of the soil on the site is classified as Twyford silt loam, and consists of approximately 30 cm of silt loam over a sandy sub-soil. Hawkes Bay Regional Council's (HBRC) 'The Soils of the Heretaunga Plains' publication estimates that this soil type has 60 mm of Profile Available Water (PAW). This soil type is well drained and is "moderately" permeable.

Irrigation Requirements

The main requirement for an orchard irrigation system is to get sufficient water to each tree, without spreading water to areas where it is not needed or cannot be used. Driplines or spraylines are often used to accomplish this.

Irrigation scheduling requirements should be determined from local climate, crop, and soil properties. Table 1 summarises the irrigation requirements unique to this property.

TABLE 1: GENERAL SYSTEM SPECIFICATIONS		
PERFORMANCE INDICATOR	UNIT(S)	SPECIFICATION
System capacity	mm/day	5.0
Application depth (range)	mm	20-30
Return interval	days	4-6
Application intensity	mm/hr	≤ 25

A system capacity of 5.0 mm/day is necessary to match the expected evapotranspiration (ET) at peak watering times.

Application depth and return interval are chosen to match the soil on the property. The depth is set to match the water holding capabilities of the soil. The return interval is set relative to the application depth, so that the soil will not dry out too much between irrigation events.

A limit on application intensity is set so that the irrigation system doesn't exceed the infiltration ability of the soil. In this instance, as long as the irrigation system applies water more slowly than 25 mm/hr, minimal ponding and runoff will occur.

The Development Process

The original irrigation design for this property was completed in 1998. A hand-shift spray line system was set up to apply 28 mm every 7 days (4.0 mm/day). At that time, the property was 15 ha in size. The owners report that the original system performed relatively well for nearly 10 years.

From 2005-2007, the owners expanded their operation to 21 ha, planting an additional 2 ha each year. The irrigation system was expanded, primarily by the owners, with very little consultation from irrigation designers. Additional mainline pipes were added to the existing system, as required, to irrigate the new blocks. The pumping system was not upgraded because the water use consent would not allow for increased flow rate.

From 2007, the owners noticed that the irrigation system was not performing as well as they would have liked, particularly on the newer blocks. After several attempts at troubleshooting the system themselves, they employed a consultant to conduct a performance evaluation of the system.

Twyford silt loam (5, 6) (photos J. Watt, E. Griffiths from Soils of the Heretaunga Plains Hawke's Bay Regional Council, www.hbrc.govt.nz)

Hand shift lines in operation on the recently planted orchard (photo Dan Bloomer - www.pagebloomer.co.nz)

Measured Performance

A performance evaluation of the irrigation system was conducted in 2009. Table 2 summarises some of the key results of the evaluation. Use Error! Reference source not found. to interpret uniformity values.

TABLE 2: SUMMARY RESULTS OF KEY IRRIGATION PERFORMANCE INDICATORS		
PERFORMANCE INDICATOR	UNIT(S)	RESULTS
IRRIGATED AREAS		
EFFECTIVE IRRIGATED AREA	ha	21
SYSTEM PERFORMANCE		
SYSTEM CAPACITY	mm/day	2.5
APPLICATION DEPTH	mm/pass	25
RETURN INTERVAL	days	10
HYDRAULIC PERFORMANCE		
APPLICATION INTENSITY	mm/h	5.5
SPRINKLER UNIFORMITY	DU_{lq}	0.50

TABLE 3: INTERPRETATION OF APPLICATION SPRINKLER RESULTS.					
RESULT	PERFECT	EXCELLENT	GOOD	FAIR	POOR
DU_{lq}	1.00	0.99 - 0.90	0.90 - 0.80	0.80 - 0.70	0.70 - less

Measured Performance continued

Visually, the system appeared to be operating relatively well. However, actual measurements revealed poor performance. This can be attributed to three main issues:

1. TOO LITTLE WATER FOR THE AREA BEING IRRIGATED

The measured flow rate was only 50% of what was required to achieve the target of 5.0 mm/day. This low system capacity means that each tree would only receive 50% of the water needed during peak demand times. This could have serious consequences for fruit quality and production.

2. LOW APPLICATION UNIFORMITY

The low sprinkler uniformity (50%) means that some areas of the orchard are receiving less water than others. This makes the water shortage problem worse. Low uniformity was caused by poor sprinkler maintenance and low mainline pressure. Some ponding was also observed.

3. LOW MAINLINE PRESSURE

The newer, larger blocks required a higher flow rate than the older blocks. This resulted in higher mainline velocity, higher friction losses, and lower pressure supplied by the pump.

Very little monitoring and maintenance was being conducted on this irrigation system. This is both a design and a management issue:

- There was no provision for pressure measurements at key locations;
- There was no water meter on the system, and;
- There were many partially blocked nozzles.

What the Farmer Could Have Done Differently

This farmer should have given more regard to the upgrade of the irrigation system, and more carefully considered what was being done.

EVALUATE CHANGES IN PERFORMANCE

Simple modifications, such as adding lengths of pipe and sprinklers, can change the hydraulics of the whole irrigation system. In this case, the new irrigation blocks were too big and the mainline pipe too small for satisfactory operation. In addition, the existing pump was too small to supply the required water for the original system and upgrades.

A systematic approach to the irrigation upgrades would have led to a more robust design. Larger diameter mainline would have been used (i.e. 4 inch aluminium, rather than 3 inch), and the pump upgraded to supply a higher flow rate. This would have cost an additional $5,000-$6,000 ($500-1,500 for larger pipe and $4,500 for a new pump), but would have resulted in higher mainline pressure, better application uniformity and the ability to better keep up with plant water demand over the whole property.

HAVE PLANS CHECKED BY A PROFESSIONAL

Expansion plans should have been checked by an irrigation professional, even for basic upgrades. An irrigation expert could have checked that pipe sizes, sprinklers, pump capacity, line spacing, etc. were all adequate, and could have ensured that the system would be capable of providing water as desired. Again, this might have cost more initially, but would have resulted in better performance, and avoided having to fix a system that was just upgraded.

CONSIDER UPGRADING THE RESOURCE CONSENT

Irrigation demand on this 21 ha property exceeds the consented flow rate. This should have been considered during the upgrade. It is likely that a slightly higher consented flow rate, and a larger pump would have solved most of the performance issues. Considering this during the upgrade may have avoided two seasons of poor performance.

CREATE MAINTENANCE PLAN/CHECK PERFORMANCE

Regular measurements of water use, operating pressure, and soil moisture would have quickly indicated performance problems, meaning they could be fixed sooner. Ways of measuring performance should be considered at the design stage.

- The cost to add pressure monitoring points to the system ($100-500) is negligible compared to the benefits.
- A good quality water meter would cost approximately $3,000, but would provide the quickest and easiest way of monitoring system performance.
- Soil moisture monitoring systems range in price from a few hundred dollars up to thousands of dollars, depending on the level of information required. However, monitoring soil moisture is the best way to know how to schedule irrigation, and to see if the irrigation system is performing adequately.