IRRIGATION
NEW ZEALAND
TECHNICAL & TRADE

CASE STUDY 3:
NORTH ISLAND SEED/CEREAL CROPS

Summary

Using the Irrigation Decision Support Package to assist with obtaining designs and quotes may have led to:

- better identification of the irrigation requirements for this property;
- better understanding of the resource consent requirements;
- better specifications being given for the irrigation expansion, and;
- a guarantee that the installed irrigation system will meet those needs.

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About this Property

This 300 ha property is located near Waipawa in Hawke's Bay. The owners grow a mixture of cereals, seed crops and green crops, as outlined in Table 1.

TABLE 1: CROPS GROWN ON THIS PROPERTY	
CROP	APPROXIMATE AREA (ha)
Maize	20
Ryegrass	30
Fescue	15
Process peas	40
Sweet corn	20
Wheat/barley	35
Pasture (irrigated)	40
Pasture (un-irrigated)	100

Approximately 200 ha of the property is irrigated; 160 ha by a travelling linear irrigator, with the remaining 40 ha by a hard-hose gun irrigator. Irrigation water is supplied from a deep groundwater well via a branched mainline pipe system.

The soil type varies considerably across this property. Table 2 summarises the soil types and their general characteristics. Generally, soils on this property hold large amounts of available water, but are not very well drained. Applied water is also slow to infiltrate into the soil on much of the property, meaning that it is easy to cause ponding and runoff with irrigation.

Each of the different soils requires a different irrigation strategy to achieve maximum production

TABLE 2: IRRIGATED SOILS ON THIS PROPERTY				
SOIL DESCRIPTION	AREA (ha)	PAW (mm)	DRAINAGE CLASS	PERMEABILITY
Poukawa peat loam	80	60	Very poorly drained	Very slow
Hastings clay/silt loam	70	110	Imperfectly drained	Slow
Hastings silt loam	30	80	Imperfectly drained	Moderate
Hastings sandy loam	20	40	Imperfectly drained	Moderately rapid

Source: Soils of the Heretaunga Plains, Hawke's Bay Regional Council (www.hbrc.govt.nz)

Hastings (14,14g), Poukawa (68) (photos E. Griffiths, Hawke's Bay Regional Council, www.hbrc.govt.nz)

Irrigation Requirements

Irrigation scheduling requirements should be determined from local climate, crop, and soil properties. Table 3 summarises the irrigation requirements unique to this property.

TABLE 3: GENERAL SYSTEM SPECIFICATIONS		
PERFORMANCE INDICATOR	UNIT(S)	SPECIFICATION
System capacity	mm/day	4.0
Application depth (range)	mm	30
Return interval	days	7
Application intensity	mm/hr	≤ 20

A system capacity of 4.0 mm/day was chosen to match the peak average evapotranspiration (ET) expected for this farm's crops during the summer months in this area.

The application depth and return interval were chosen to match the lighter soils. Lighter soils cannot hold as much water and will dry out more rapidly. Therefore, they require lower application depths and short return intervals to maintain adequate moisture content.

Conversely, application intensity was chosen to match the heavier soil. Water does not infiltrate as quickly into the heavier soil, so water must be applied more gently.

The Development Process

When the current owners purchased this property, there was an existing hard-hose gun system already in place, covering 40 ha. The remainder of the property had no irrigation in place.

The owners contracted an irrigation company to design a 160 ha expansion to the irrigation system. A pump test showed there was plenty of capacity in the existing well to supply the expanded area.

A linear irrigator, new pump and mainline were installed for the new areas. The system supplier quoted a 4.0 mm/day system capacity for the expanded system.

A performance evaluation was conducted on the completed irrigation system some years later, as part of an irrigation research project conducted by the Regional Council.

Measured Performance

Table 4 summarises some of the key results of the performance test of the irrigation system.

TABLE 4: SUMMARY RESULTS OF KEY PERFORMANCE INDICATORS				
PERFORMANCE INDICATOR	UNIT(S)	LINEAR	HARD-HOSE GUN	TOTAL
EFFECTIVE IRRIGATED AREA	ha	160	40	200
SYSTEM CAPACITY	mm/day	2.9	3.5	3.0
FLOW RATE	ℓ/s	54	16	70
APPLICATION DEPTH	mm/pass	17	40-50	-
RETURN INTERVAL	days	6	12-16	-
APPLICATION INTENSITY (AVERAGE)	mm/h	43	8	-
APPLICATION INTENSITY (INSTANTANEOUS)	mm/h	43	Very high*	-

* This was not measured, but the instantaneous intensity of the jet from the gun's nozzle can be many times the average intensity.

Measured Performance continued

The measured system capacity was found to be lower than quoted (3.0 vs 4.0 mm/day). This means that crops will not receive all of the water they need during times of peak ET. It is unclear how the system was meant to achieve 4.0 mm/day, when the consented flow rate (75 ℓ/s) would allow for a maximum of 3.2 mm/day over the 200 ha. A flow rate of 92 ℓ/s is required to achieve 4.0 mm/day over 200 ha.

The application depth and return interval of the linear irrigator were within the practical limits of the soil. However, the application depth was too great and the return interval too long under the hard-hose gun. This means that the 40 ha irrigated by the gun is receiving too much water on each run. These areas will experience moisture stress between applications, and production is expected to suffer.

Ponding was observed on the heavier soils. This indicates an application intensity that is greater than the infiltration rate of the soil. Ponding is consistent with intensity measurements; the linear had an average application intensity of 43 mm/hr, which is greater than the 20 mm/hr soil infiltration rate. This is likely to result in uneven infiltration of water into the soil, meaning that the water will be less effective - irrigation efficiency is lower.

High friction losses were measured in many of the mainline pipes.

What the Farmer Could Have Done Differently

CONDUCT A BETTER NEEDS ASSESSMENT
Take the time to step back and look at the system holistically prior to upgrading. This should include an assessment of the existing irrigation, not just new areas. In this case, an assessment of the existing irrigation relative to the limitations of the soil may have led to the replacement / modification of the hard-hose gun system. While this would have initially cost more, the resulting system would have been better matched to the soils, resulting in improved long-term performance and production gains.

PROVIDE A CLEAR SPECIFICATION
Provide better performance requirements to the designer. For example, expressing a preference for low pipe friction losses would have saved on long-term pumping costs. It would have cost more initially because larger pipes would need to be installed (estimated additional $25,000), but would have significantly reduce energy consumption ($6,400/yr for 8 m of pressure loss avoided). It would also extend the working life of the pipe.

CONSIDER UPGRADING THE EXISTING IRRIGATION
The operation of the hard-hose gun doesn't match the soil types on this property (application depth is too high and return interval is too long). Replacing the gun with a different form of irrigation has the potential to increase irrigation performance, thus boosting production.

The hard-hose gun also operates at a significantly higher pressure than the new linear irrigator – it uses a small pump to boost the mainline pressure at the gun hydrant. An estimated $4,000/yr could be saved by using a lower pressure irrigator that does not require the booster pump.

CONSIDER UPGRADING THE RESOURCE CONSENT
The current resource consent does not provide a high enough flow rate to meet peak irrigation demand on this property. This should have been considered during the upgrade, both by the designer and the farm owner. Maximum production will not be achieved unless the consent is upgraded to allow for a water application of 4.0 mm/day.

INCLUDE PERFORMANCE EVALUATION IN THE CONTRACT
Verification of system performance should have been included in the contract for the supply of the system. It should have stated the criteria that needed to be met (e.g. those in Table 3), as well as who was responsible for the commissioning and testing of the system. This would have highlighted any issues (e.g. the low system capacity) straight away, and steps could have been taken to correct them before they impacted on production.