PRECISION IRRIGATION AS A TOOL TO REDUCE NUTRIENT LEACHING AND RUNOFF

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Situation

Conventional centre-pivot or lateral-move irrigation is designed to efficiently deliver a blanket volume of water to the area it is working in. A centre-pivot irrigator is nozzled so that less water comes out of the slow moving nozzles near the centre point, and progressively more water comes out of the nozzles further away from the centre point as the relative ground speed of those nozzles becomes greater. This design means that if you run the irrigator at such a speed that say 10mm of irrigation should be applied to the soil surface, at all distances from the centre-point, the soil receives 10mm of water.

Although this is a very efficient method of applying irrigation to fields that require exactly the same amount of water everywhere, the reality is that due to different characteristics like soil type, crop being irrigated, history of irrigation, and other external factors, not every square metre of ground area requires the same amount of irrigation. We can loosely think of the soil's profile as a bucket of soil with holes in the bottom. The bottom of the bucket signifys the crop's root depth. We can apply water to the bucket, but at some point the air pockets in the soil in the bucket will saturate and if we continue to add water the bucket will overflow and/or leak out the holes in the bottom. This is the same as what happens with irrigation in a field, the complication being that every part of the field will have a slightly different looking bucket. Due to these differing soil characteristics over the field there becomes a need to be able to vary the amount of irrigation applied so that we don't waste water through runoff, ponding or leaching, and to take advantage of the soils full water holding capacity.

Figure 1. Low lying wet area of a field that would benefit with reduced irrigation to reduce or eliminate ponding.

Many farmers have correctly identified that in terms of crop health, over-irrigation can be just as bad or worse than under-irrigating. As the soil profile can only hold a finite amount of water before it saturates, any excess irrigation either ponds, runs off, or leaches through the soil out of the root zone. As well as wasting the water, it also takes valuable nutrients with it and is a cause of pollution.

How we are addressing the problem

Using EM (Electromagnetic) soil mapping, differences in soils can be classified. An EM sensor coupled with GPS allows us to build a picture of the conductivity of soils in a field. As the conductivity is affected by the water in, and therefore the water holding capacity of the soil, we can then process the EM resullts into a map showing available water holding capacity spatially and further classify the field into several different zones of similar composition. These zones can then be treated independently according to their specific characteristics..

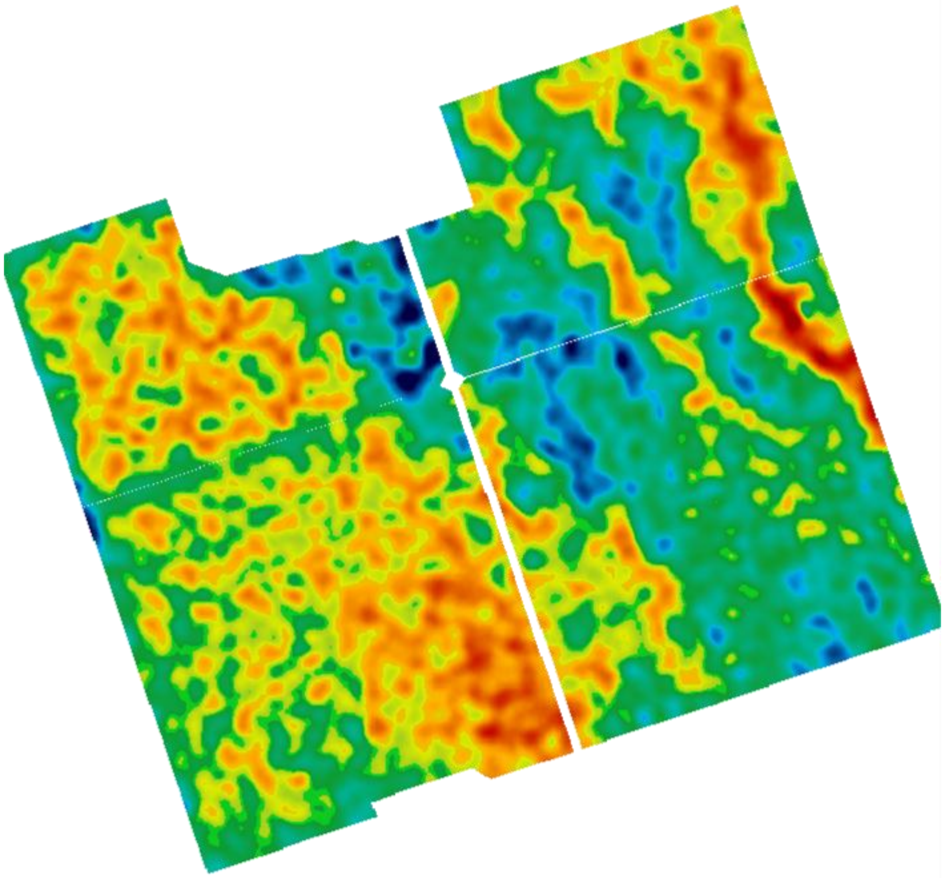

Figure 2. An EM Map produced by Agri Optics New Zealand Ltd showing differences in soil characterics

Translating to irrigation; a possible scenario might be an irrigator that operates on two terraces. The upper terrace may have a silt loam profile that can hold a lot of water, and the lower terrace a very stony riverbed that cannot hold as much water as the upper terrace and therefore requires less water, but more often.

By measuring the real-time soil moisture status in each of the management zones, we can create maps derived from the zoned EM map, and program different depths of irrigation for each of the zones in order to bring them up the required moisture level and not past saturation.

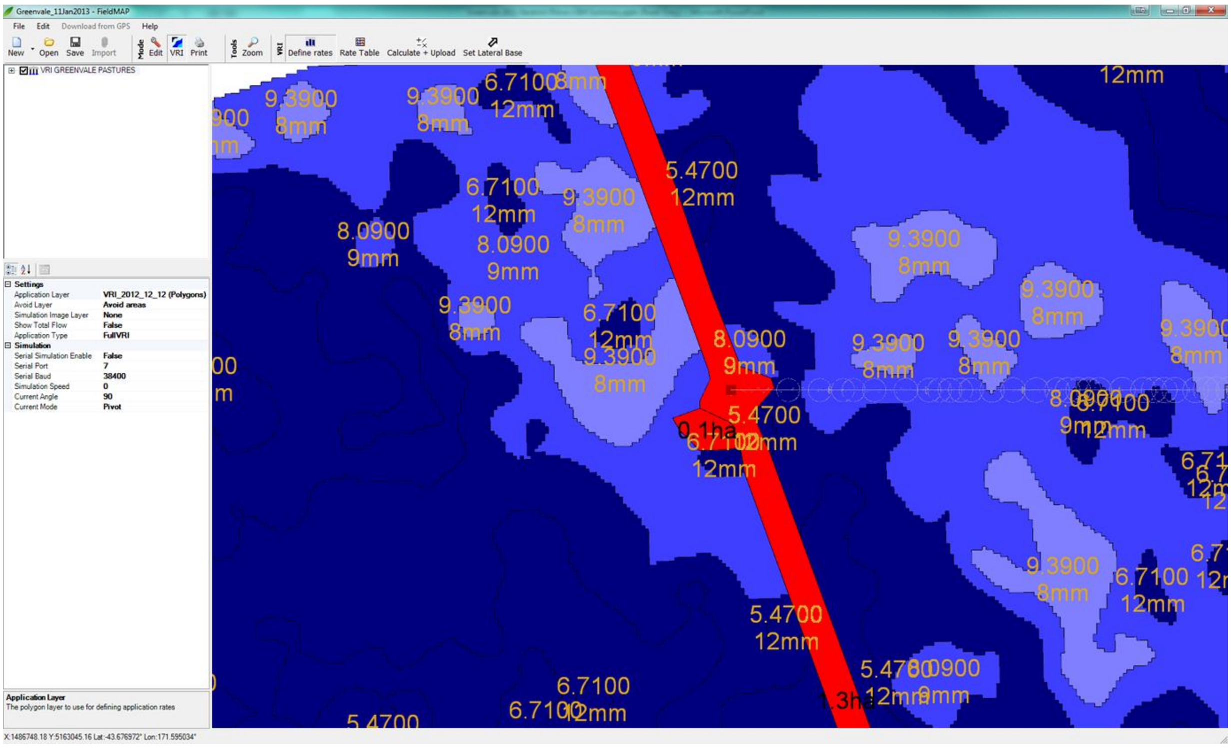

Figure 3. Different depths of irrigation programmed to be applied to different management zones

Once the management zones are identified and depths of irrigation have been programmed for each zone, a Precision VRI (Variable Rate Irrigation) equipped irrigator is able to apply the irrigation at the prescribed depths.

Precision VRI works by controlling valves along the length of an irrigator, turning them on, off, or pulsing to achieve the desired depth of irrigation that is prescribed in the map-based FieldMAP software.

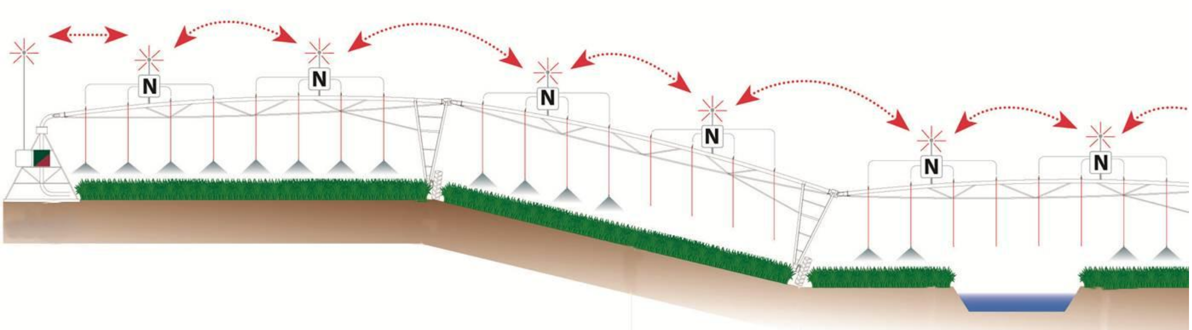

Figure 4. Precision VRI system layout with a controller at the centre-point (left) sending wireless signals to nodes (N) along the length of the irrigator which then switch individual valves on, off or pulse them to achieve a desired application depth.

By monitoring what is happening in the soil management zones, irrigation prescriptions can be tweaked to achieve efficient irrigation and reduce drainage and leaching.

Figure 5 shows how stony soil could benefit from less irrigation being applied to reduce drainage and leaching at 50cm deep, whereas in the silt loam soil there is no drainage at 50cm deep. Variable Rate Irrigation could be used to achieve this.

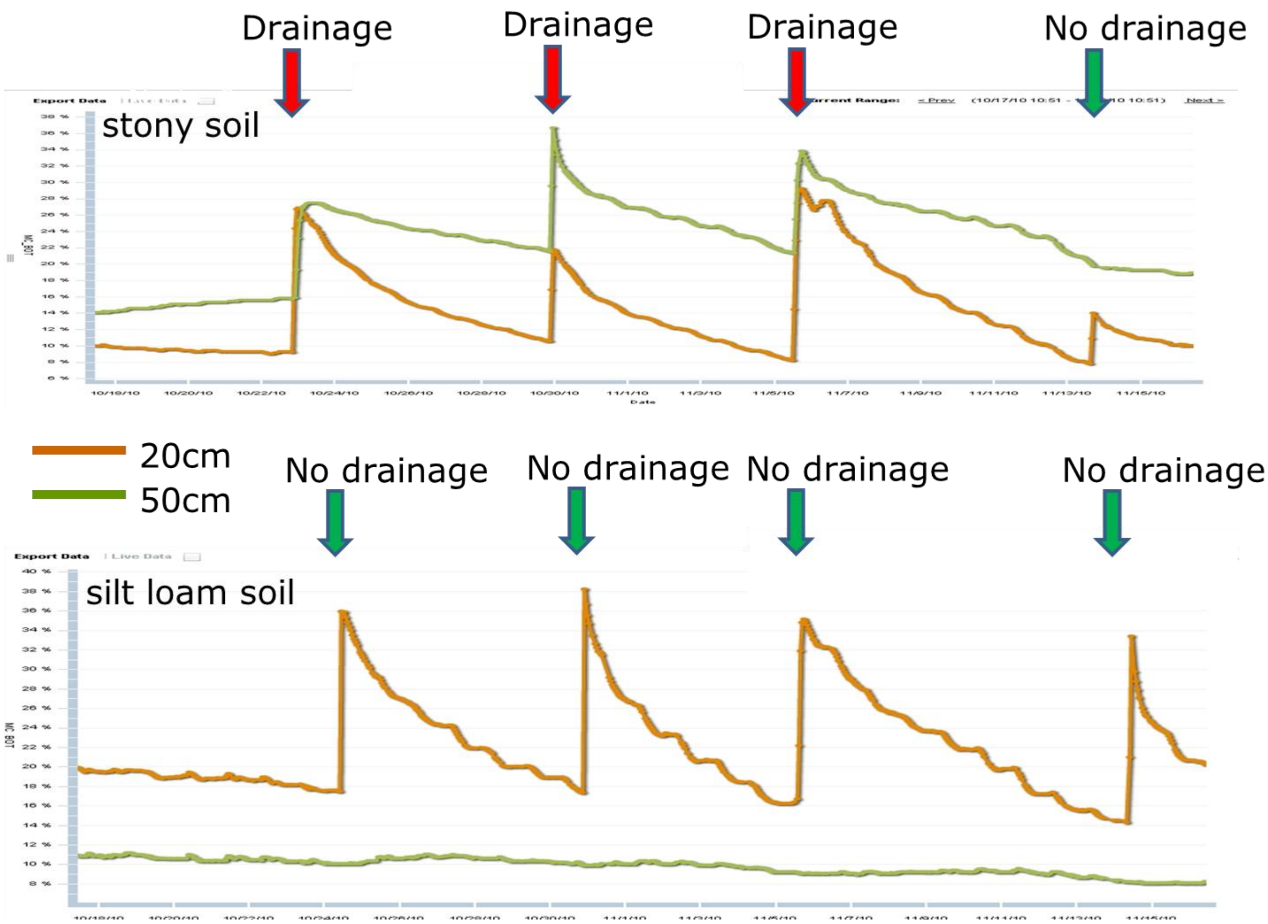

Figure 5. Real-time monitoring shows the difference between inefficient irrigation (top graph) where there is drainage at a depth of 50cm, and efficient irrigation where there is no drainage at a depth of 50cm.

In order to gain maximum efficiency and to measure how effectively irrigation is being applied, tools such as real-time monitoring and recording of soil moisture and irrigation can be utilised.

Figure 6 shows how Precision VRI can be tracked through www.precisionirrigation.co.nz, using a unique farmer login that brings up the irrigator and how much irrigation was applied spatially over a given date range.

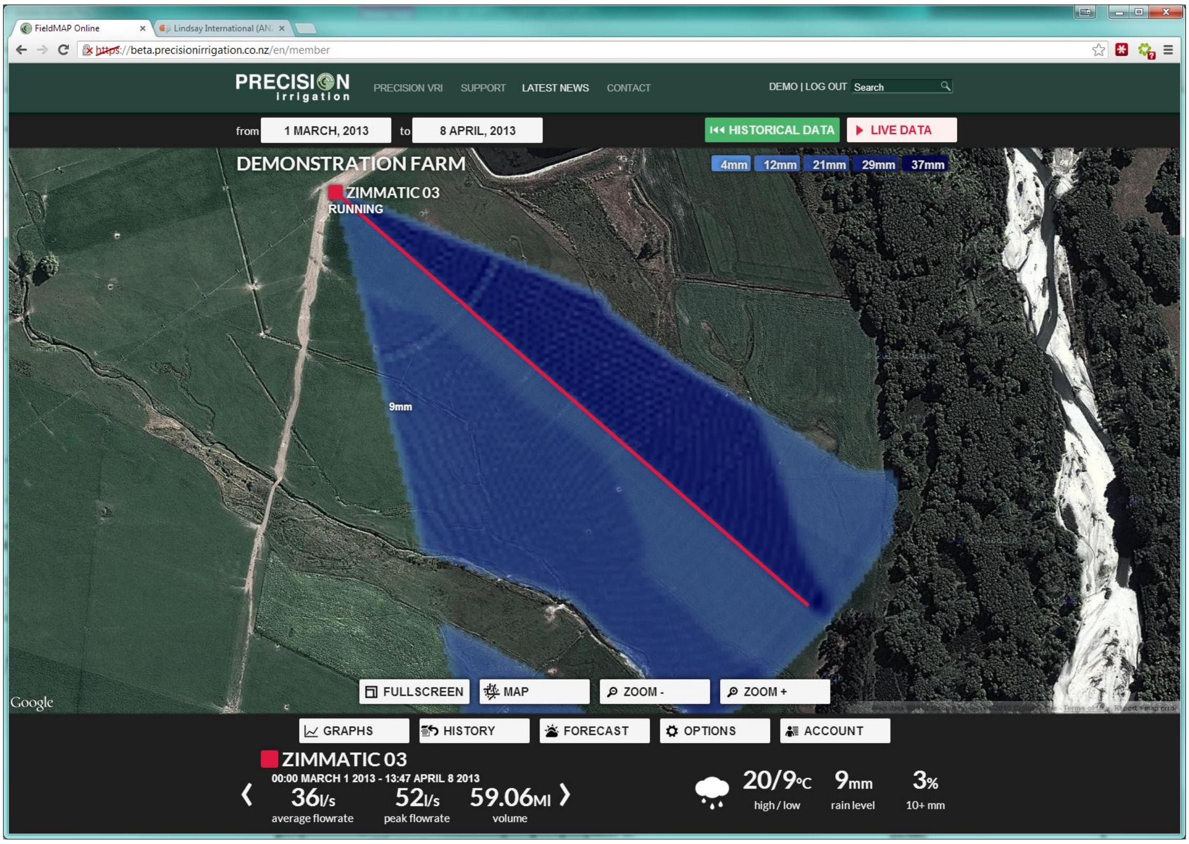

Figure 6. Online recording and reporting through www.precisionirrigation.co.nz

Variable Rate Irrigation is a tool with many benefits, primarily known to save water and increase yields under centre-pivot and lateral-move irrigation systems. However, many VRI owners have found other spin-off benefits such as

- Improved animal health of cows not walking on wet tracks,
- Ability to keep areas around troughs dry,
- Ability to renovate pasture in individual paddocks by keeping them dry while irrigating other areas
- Ability to keep irrigation off areas being harvested while still irrigating other areas,
- Ability to withhold irrigation from wet patches (e.g. compacted soils or low lying areas)
- Water consumption reduced enough to extend the irrigation season or run further irrigation without sourcing more water.

Summary

By classifying the area beneath a centre-pivot or lateral-move irrigator, VRI can be used to apply different depths of irrigation over a field to match soil and crop requirements. By monitoring soil moisture levels, irrigation can be variably scheduled to apply only enough water to keep soil moisture optimal, and to be prepared for rain events that could lead to runoff or leaching. By controlling the soil moisture status spatially in this fashion, further water can be saved, and nutrients can be conserved in the root zone by reducing the risk of leaching and runoff which is hard to avoid with normal uniform irrigation scheduling.