

# Precision dairy technology

## Variable Rate Irrigation

### What is the technology?

Variable rate irrigation (VRI) technology allows farmers to apply varying rates of irrigation water to individual management zones under their centre pivot irrigation systems.

### How does it work?

Water is applied via a centre pivot irrigator equipped with either a sector or a zone control VRI system to specific management zones by a control panel loaded with a prescription map.

- › A sector control system varies the speed of the pivot in each sector or pie-like wedge, with faster speeds reducing water depth applied, and slower speeds increasing water depth applied.
- › In a zone control system, water can be variably applied in the direction of travel and along the length of the centre pivot. Solenoid valves

are fitted to each nozzle, and by pulsing the valves at different rates, the desired application depth within each management zone on the prescription map can be achieved. This enables applied water depths to be matched with the spatial variation in soil properties, or crop type, in each management zone.

### Producing a prescription map

The use of a professional service is usually required to quantitatively assess the variability under each VRI equipped centre pivot, and produce a prescription map of the specific management zones that will have varied depths applied to them.

Irrigation requirements within a field will be influenced by soil type, topography, crop type and growth stage, soil moisture status, and field layout. Typically, a base map is created that best describes the overall field variability in soil moisture requirements, and then information specific to the crop and field is overlaid on that.

A common first step in the base map creation is a site survey to map the soil conductivity and elevation.

- › Soil conductivity is mapped using an electromagnetic (EM) sensor dragged across the soil surface. The conductivity changes in response to changes in soil clay content, salt levels and moisture content.
- › Elevation data can be collected using an accurate GPS system or a calibrated drone image. The GPS data is often collected at the same time as the EM survey, however it may also come from the farmer's tractor if it has a RTK GPS systems. The elevation data can be used to produce a model of the surface of the paddock. This model can then be used to predict where water will flow and accumulate, and this can also be integrated into the final VRI base map.

Each paddock is unique in what factors are the main influences on the best base map. The EM maps and water flow maps need to be taken into the field to observe how everything can be combined to produce the most relevant map for that field. Often there are also areas that the maps hadn't accounted for, such as factoring in water flowing from adjacent paddocks. These can be mapped manually at the same time.



Finally, all the different contributing maps are combined to produce one single base map that best approximates the variable irrigation needs in the paddock. Once the base map is prepared other factors are added, such as unplanted areas, drains, internal lane ways, and water troughs that the grower may want to keep dry. Often, wheel tracks over wet areas are also excluded from watering to reduce bogging risk.

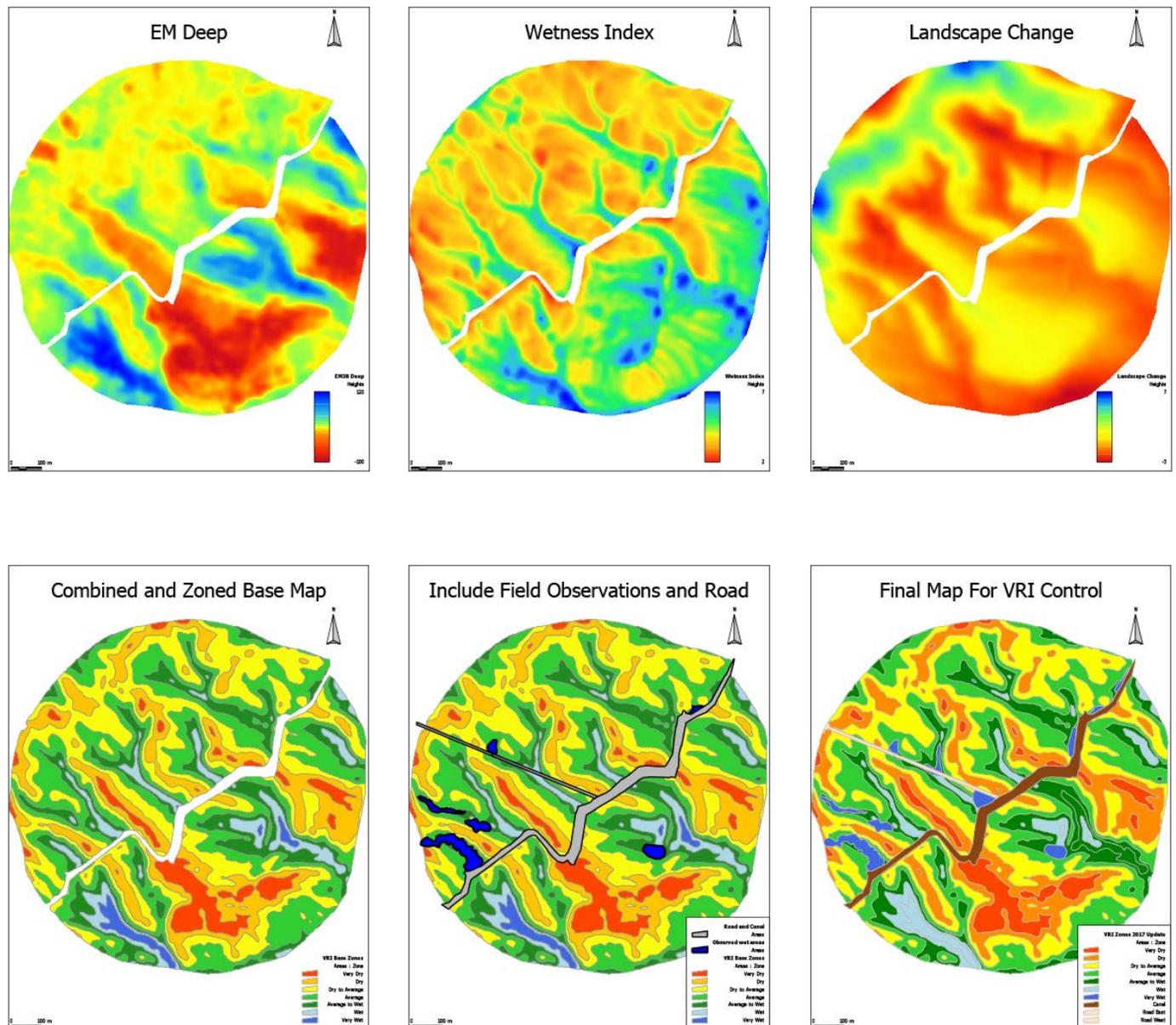
Other inputs that can be used in the process include visual satellite images, such as those on services like Google Earth. Data from Google Earth is free, but useful images may not always be available. Alternatively, vegetation variability can be used to derive

irrigation management zones by using yield, leaf area index or Normalised Difference Vegetation Index (NDVI). NDVI data derived from satellite or drones provide a measure of vegetation density and condition that indicates the photosynthetic capacity of the crop and hence the potential irrigation demand.

The complete prescription map (Figure 1) is converted into a file to control the pivot via a number of pathways. Some systems utilise software loaded onto the grower's computer and a control file is manually loaded onto the pivot. Most modern systems use a website to provide both the interface to load in the map, and also to send the control file remotely to the pivot. Irrigations

completed by the VRI centre pivot then have different depths applied in the different management zones.

Soil moisture sensors are also often installed into different zones to monitor real-time soil moisture status. This information is then used to optimise variable rate irrigation scheduling. There are a number of systems in development that will enable autonomous production of prescription maps based on near real-time data from infield sensors such as soil moisture probes, and climate and crop growth parameters that are fed into a control module.



**Figure 1** The development of the final prescription map for VRI control of a centre pivot. (Images supplied by Reuben Wells, Ag Logic Pty Ltd)

## How can we use this information?

VRI can be used to:

- › exclude irrigation from drains, gateways, laneways, water troughs, streams and other infrastructure under your pivot
- › vary irrigation according to crop differences under irrigation
- › delay startup and reduce irrigation on wetter low-lying areas that get boggy
- › apply varying amounts of irrigation to soil zones according to their plant available water storage
- › exclude irrigating paddocks where pasture renovation or silage making is occurring
- › exclude irrigating dairy paddocks the day before they are grazed.

Water is saved through matching irrigation to land and soil characteristics, and avoiding watering unproductive land. These farm management strategies are providing more efficient use of irrigation water and the water saved can often be redistributed to other parts of the farm.

## Benefits

There are likely to be many benefits from installing a VRI on a pivot irrigator. These include:

- › improved crop quality and yield by up to 20%
- › savings on water volume of 20 to 30% on dairy and field crops are achievable
- › reduced pumping (energy) costs
- › reduced soil saturation and so improved grass growth, as well as less pugging damage in wetter areas
- › reduced muddiness on laneways and easier movement of cows across paddocks.

## Potential issues

During the growing season there are often changes in the spatial distribution of growth in the crop or pasture. Irrigation scheduling may call for a different water application rate to the different management zones as crop water demands change. This may require uploading of up to three zone control maps to the control panel and then choosing the appropriate zone map as the growing season progresses.

Variable frequency drive (VFD) pumps to supply the correct pressure and flowrate to the pivot are of value when they are provided information about the desired requirements by the system governing the VRI prescriptions. When implemented correctly, this VFD system would minimize pressure fluctuations resulting from turning off a large number of sprinklers that are nearer the end of the machine. These controlled pumps would provide the right amount of flow and pressure to the pivot to account for the varying application depths required in the prescription map. Additional components are required for Zone VRI including independently controlled sprinkler valves, sprinkler control valve boxes, and a VRI control panel.

## Suppliers and cost

VRI technology is available to operate with centre pivot machines from all major suppliers and manufacturers.

Precision VRI technology has an installed cost of between \$600/ha and \$1500/ha and this cost would include sprinkler valve hardware, GPS software & remote telemetry access. The cost of a VFD controller for the pump would be additional to this.

Research has shown that a VRI system can pay for itself within one irrigation season, but this will depend largely on the amount of variability existing on the site.

## Further information

More detailed information on VRI may be found on the Dairy Climate Toolkit site at [dairyclimatetoolkit.com.au](http://dairyclimatetoolkit.com.au) particularly the 'Planning for VRI Fact Sheet' together with an excellent video of the use of VRI in dairy production, which can be accessed through the following [link](#).

For specific information, contact your local irrigation hardware supplier or licensed irrigation consultant.

More technical information is provided by the scientific publication. Adoption of site specific variable rate sprinkler irrigation systems, Evans, R.G, LaRue, J. Stone, K.C. et al Irrigation Science (2013) 31:871.

*Dairy Australia acknowledges Dr James Hills, Senior Research Fellow, Tasmanian Institute of Agriculture Dairy Centre, phone 03 6430 4937; email [James.Hills@utas.edu.au](mailto:James.Hills@utas.edu.au) for collating much of the information from Tasmanian Institute of Agriculture, National Centre for Engineering in Agriculture and Ag Logic Pty Ltd, and preparing the final draft of this Fact Sheet.*

Published by Dairy Australia Limited.

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