Getting started in PA

Precision agriculture in vegetable systems

Knowing where to start with precision agriculture in vegetables can be daunting. As part of a Hort Innovation funded national project in precision agriculture, the Queensland Department of Agriculture and Fisheries (DAF) has identified some initial steps vegetable producers can take to get started with precision agriculture (PA).

Tractor guidance

The starting point for any precision approach is always guidance. At the very minimum, guidance reduces overlap and errors. It also provides the basis for geo-referencing, and without that, it is difficult to move to any precision farming approach.

Having precise location data enables the following PA applications:

- VR applications of nutrients, soil ameliorants and irrigation water,
- spatial soil characteristic mapping,
- crop yield mapping,
- controlled traffic farming and reduced tillage practices such as strip tillage,
- deployment of field robotics.

Figure 1. *Google Earth image of 'polygon' field boundary.*

Map field boundaries

Any spatial data collected on farm will need clearly identified field boundaries to assist with identifying fields for data collection or with processing of spatial soil or crop sensing data. This can be easily done in Google Earth by creating what's known as a 'polygon' around individual fields (Figure 1) and labelling these with Field IDs or by mapping field boundaries with tractor guidance.

Elevation data

RTK tractor guidance systems also have the capability to log topographical (elevation) data (Figure 2). The elevation data collected by these highly accurate systems (< 5 cm vertical accuracy) can then be developed into a Digital Elevation Model (DEM). This type of map can be used to design farm layout to optimise surface water management and also forms the basis for drainage modelling for more efficient levelling and to inform drainage works.

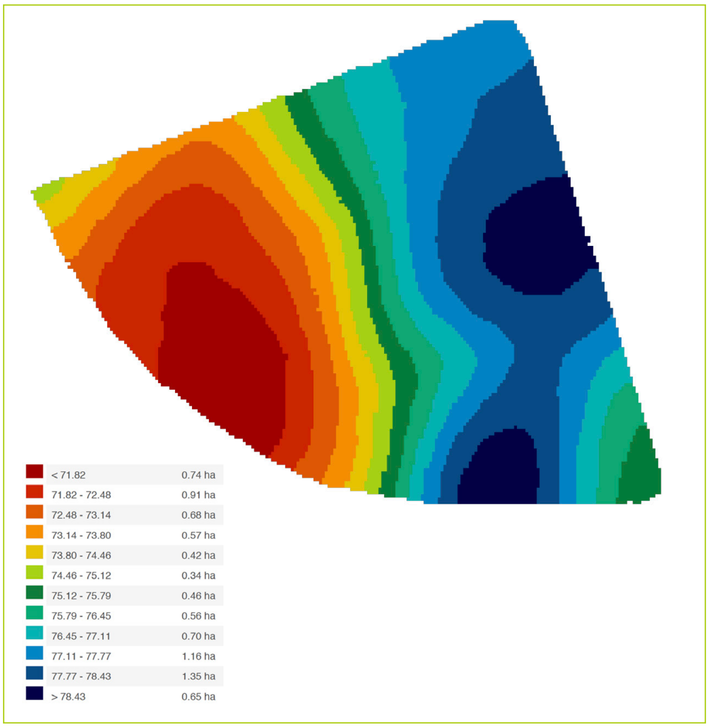


Figure 2. *Elevation map from RTK tractor guidance.*

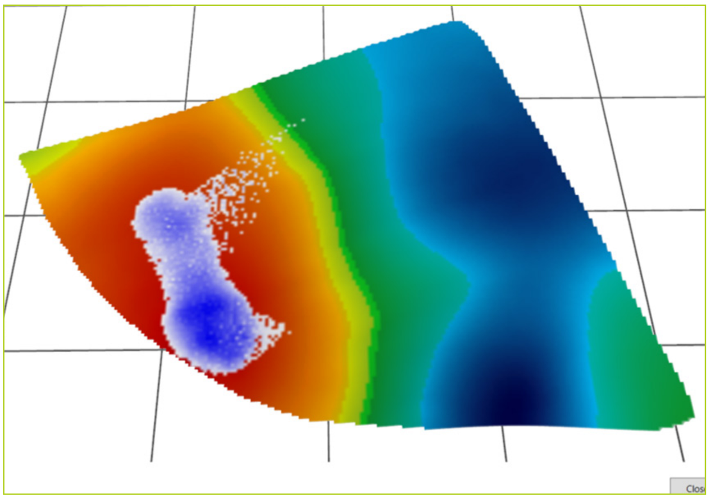


Figure 3. Water modelling. Source: Ag Tech Services.

To ensure the level of accuracy needed for drainage modelling, it is best to log this data as a separate operation without any implements behind the tractor. As this data can be captured with on-farm machinery, this requires minimal capital outlay, although you may need access to expert advice for data processing and modelling (Figure 3).

SENSING IMAGERY

Crop sensing

There are low cost options for crop sensing to assess the extent of any variability. This can be trialled easily by using one of the freely available platforms to access crop Normalised Difference Vegetation Index (NDVI) imagery such as (Data Farming: https://www.datafarming.com.au/ IrriSAT https://irrisat-cloud.appspot.com/). The freely available NDVI imagery is generally low resolution (10–30 m pixels) (Figure 4). Higher resolution is available at a cost and it is this higher resolution that will be most beneficial for vegetable systems given the intensiveness of production systems.

NDVI is not the only vegetation index available for crop sensing. There are a range of other indices that may be better options in vegetables depending on the situation.

When using these free platforms, be mindful that the resolution may not be sufficient for some vegetable crops, and where there are multiple planting dates within the one field it may be best to look at each planting date separately as well as the whole field. Where possible, download these files as a KMZ file so the NDVI map can be opened in Google Earth, allowing you to use location services for ground-truthing.

Imagery captured by drone or UAV may be more beneficial for the smaller areas of production associated with vegetable production, multiple planting and harvesting times and to achieve higher resolution (Figure 5). Drones can provide evidence of variability through high resolution digital images of the crop, 3D crop models or multispectral imagery to give a range of crop vegetation indices. If using drone services, make sure you understand what you want from the imagery so the correct sensors are used.

Soil sensing

Similarly, there are a range of soil mapping technologies that can be used to understand soil variability, many of which are relatively low cost.

While the type of soil mapping used depends on the issue, all require some soil sampling to ground-truth the mapping data and relate to measured soil parameters (see Soil mapping factsheet).

Data interpretation and ground-truthing

Once you have obtained crop sensing imagery the next key considerations are:

- Is there any variability? Are there spatial differences evident in the crop imagery? If differences in crop imagery are evident then use the KMZ to locate different areas of the field and pull some plants out from the 'high' and 'low' areas, and compare.

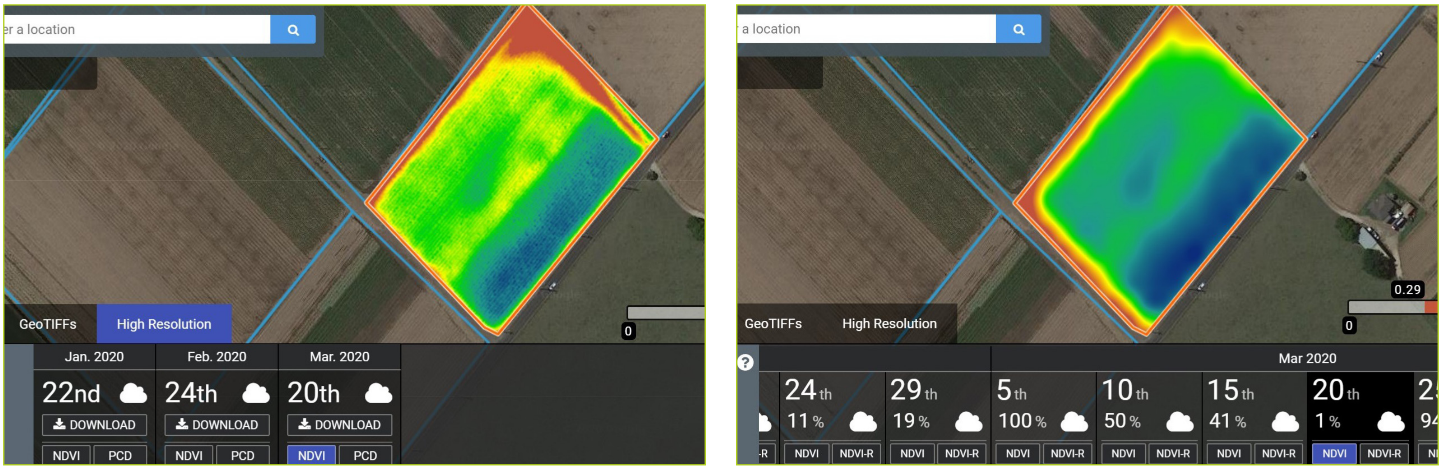


Figure 1. Left: High resolution NDVI imagery. Right: Low resolution NDVI imagery. Source: Data Farming.

- How is this impacting on your crop? Is it significant enough to warrant some management intervention? To understand this, hand harvest areas of the crop at maturity based on the crop imagery, i.e some from high crop vigour areas and some from low crop vigour areas and compare yield and quality.

These steps are often not done yet are necessary to quantify whether variability warrants a PA approach.

If crop variability is significant in terms of productivity, the next steps would be to explore what might be causing it. Investigate in-season causes first – such as pests, disease and irrigation variability. If these are not the cause, you may need some sort of soil mapping. Understanding the cause of variability is the first step towards managing it.

Data management and research

Precision approaches generate large volumes of data. Consider what you will need in data outputs and negotiate these requirements with any service providers.

There are a range of digital data platforms for spatial data storage, analysis and viewing that are readily accessible e.g. PCT, Decipher Ag, etc. These tend to be cloud based and while they may have free online versions these are usually of limited functionality. Greater functionality is achieved through subscription based access.

Talk to precision agriculture service providers. While some regions have limited local precision agriculture service providers, most providers will generally travel.

Talk to other growers who have used some of the technologies and approaches you are considering.

Make use of Google and the wealth of precision agriculture learnings that have come from other industries. The Society for Precision Agriculture Australia (SPAA) hosts a range of independent precision agriculture resources on their website (www.spaa.com.au).

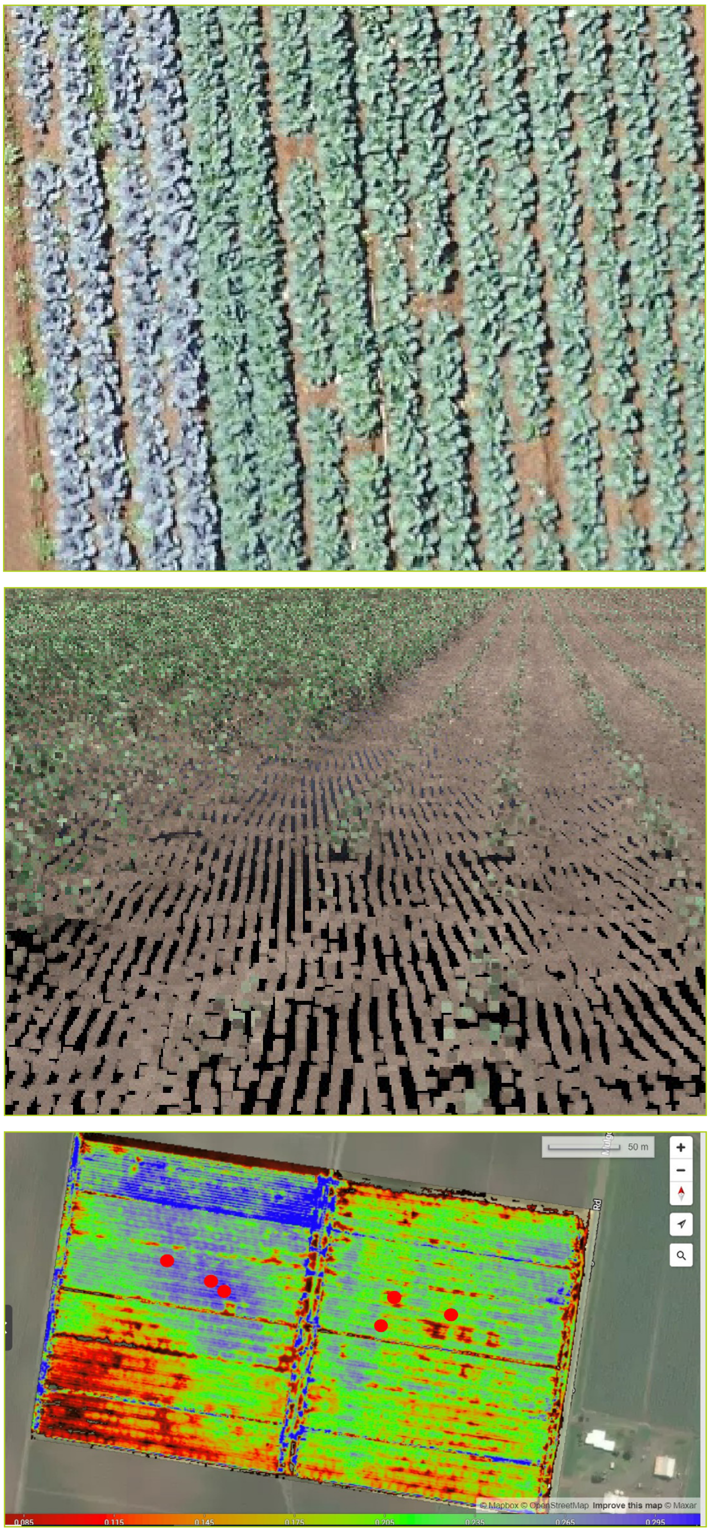


Figure 5*. Drone imagery of vegetable crops: Top: High resolution RGB of brassicas. Middle: 3D model from RGB imagery of sweet corn. Bottom: Multispectral imagery, NDRE vegetation index of green beans, with ground-truthing sample points.*

CONTROLLED TRAFFIC FARMING

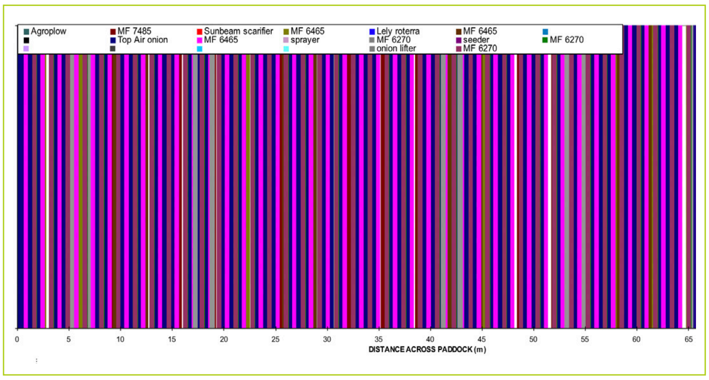
Controlled traffic is often under-recognised as a part of precision farming systems. The key basis of controlled traffic is compatible dimensions of machinery track gauge and working width across all field machinery. While the key requirements of controlled traffic lie in matching machinery dimensions, satellite guidance is an important enabling technology.

Controlled traffic involves returning to the same wheel tracks for each operation in the field (Figure 6). If the farming system is based on beds, this will happen by default, at least during the growing season. This is not necessarily the case in other systems. This is where guidance becomes important for finding the correct location of wheel tracks (A-B line) and being able to steer along the same lines for each field operation.

The final part of the controlled traffic approach is to minimise disturbance of the wheel tracks and crop beds as much as possible. This is often challenging in vegetable production, particularly when wheel tracks might become rutted during a wet harvest, or the tyre configurations on harvesters might not match with the rest of the machinery. It tends to be much easier in hand-harvested bed systems.

KEY TIPS FOR GETTING STARTED

- Understand why you may want to implement PA approaches i.e is it to reduce variability, or improve productivity, or to optimise inputs, as this will help determine where to start.
- Start small and pilot tools before expanding.
- Research or seek advice prior to adopting.
- PA is for the longer term – variability will not be able to be ‘fixed’ immediately.



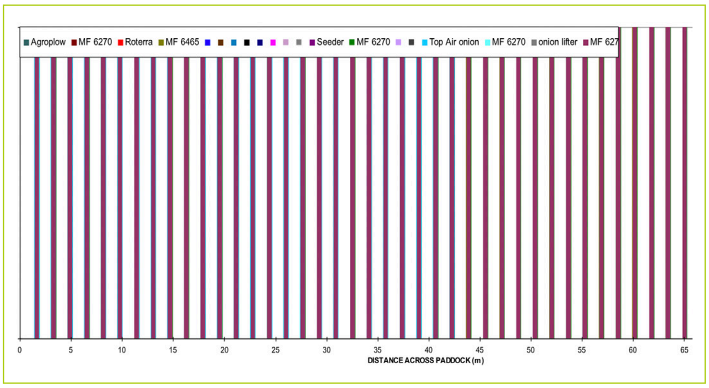


Figure 6. *Top: Traffic map of conventional use of machinery in an onion field (wheeltrack area 95%). Bottom: Traffic map when machinery is confined to permanent CTF wheeltracks (wheeltrack area (28%). Source: John McPhee, Tasmanian Institute of Agriculture.*

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