Absolute Sense^{TM} from Leonardo

"Decision Support That Makes Absolute Sense^{TM}"

Leonardo has a long and distinguished heritage in being able to extract knowledge from data, particularly in the military marketplace. Data from complex RADAR or Defensive systems is regularly analysed and from the knowledge gained, information is presented to pilots in a straightforward and meaningful way, thus ensuring they can make timely and mission critical decisions.

In much the same way, farmers need to make timely and commercially critical decisions in order to apply fertilisers to maximise yield whilst minimising the impact to the environment and overall cost.

Today, NDVI is the most commonly used measure of crop health and presents to farmers, in relative terms, a display of the areas that are defined as 'better' and 'poorer'.

Using its Data Mining and long history of military data analytics, Leonardo has applied this expertise to the domain of farming – and in particular to remotely sensing Nitrogen content in a winter wheat crop.

Algorithm Development – Nutrient Mapping

Leonardo has performed trials in winter wheat crops across different geographies in the UK for the past 4 years. Each year, crops were sampled at different growth stages (from 21 through to 61 on the Zadoks scale or 2 through to 10.5 on the Feekes scale) and corresponding

hyper spectral data captured remotely from a manned fixed wing aircraft. Subsequent lab analysis was performed on each of the crop samples to determine nutrient content and to provide the ground truthed values. The position of each ground truthed point was recorded using accurate in-field GPS equipment and then aligned to the exact remotely sensed hyper spectral data pixel.

The development of an Absolute Sense^{TM} nitrogen detector for winter wheat begins with a spectral profile captured from the hyper spectral sensor (VNIR and SWIR). Taking the 460+ individual frequencies and applying sophisticated data mining techniques, along with the ground truthing data relating to each individual GPS sample point, a characterisation of the plant nutrient is created. The methodology is transferrable to the detection of other nutrients in winter wheat, such as Phosphate, Potassium and Sulphur.
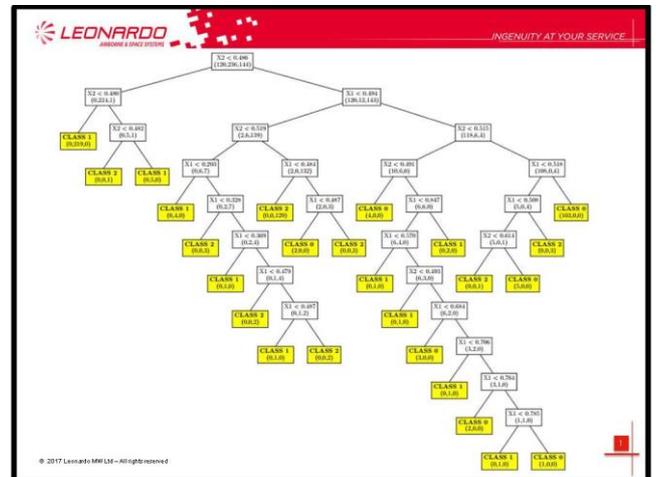
As drone based hyper spectral sensors are not widely available or used in agriculture currently, Leonardo targeted its initial model development to the MicaSense RedEdge and Parrot Sequoia multispectral sensors. These sensors are both widely available and proven on various drone platforms used within agriculture today. Taking the hyper spectral developed solutions,

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multispectral solutions were created by adapting the algorithms to operate within their constrained frequency range. This was achieved with a marginal loss in overall performance.

The models that are available today through the PrecisionHawk PrecisionMapper AlgoMarket have characterised the key growth stage range from 21 to 31 where the majority of Nitrogen fertiliser is applied to a winter wheat crop. Updates to these models will be released later in 2017 supporting growth stages 21 through to 61, with further refinement using data from the latest growing season.
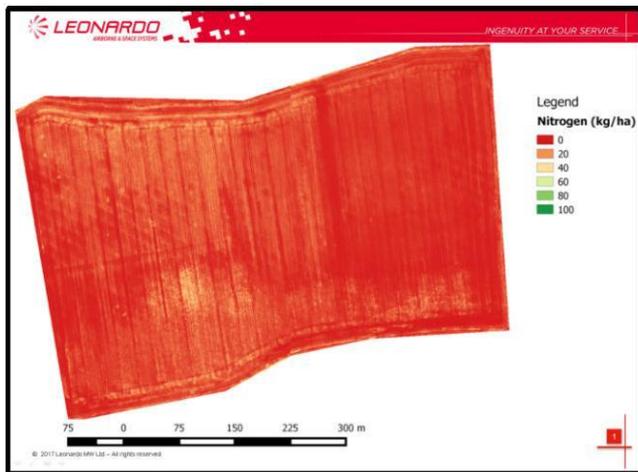

Farmers, agronomists and other agricultural service providers can use these maps, which show the actual crop content of N in kg/ha, as an additional tool in their toolbox to support decisions when calculating how much fertiliser to apply, when and where. Leonardo intends to supply an additional tool through the PrecisionMapper website to assist customers with prescription calculations later this year.

Prescription Mapping

Using the nitrogen detector, the next logical step was to create prescription maps, allowing farmers to apply fertiliser with precision. In 2015, Leonardo trialled prescription mapping in partnership with a leading agronomy company, a

fertiliser manufacturer and a precision sprayer developer. Utilising the Absolute Sense^{TM} nitrogen detector, a crop nitrogen content map was created for the whole trial field. This map was used as the basis for a prescription map in conjunction with the agronomists providing expertise into optimising fertiliser distribution (typically *MORE ON MORE* or *LESS ON LESS*, depending on which growth stage the prescription map was being used for). For the 2015 trial, various prescription maps were generated using the methods as suggested by agronomists and used to control the precision sprayer. Three separate applications of nitrogen fertiliser were applied throughout the relevant growth stages, thus enabling evaluation of the yield to be carried out. Analysis of the resulting yield showed an increase of up to 14% was achieved while at the same time reducing the overall fertiliser usage by up to 7%.
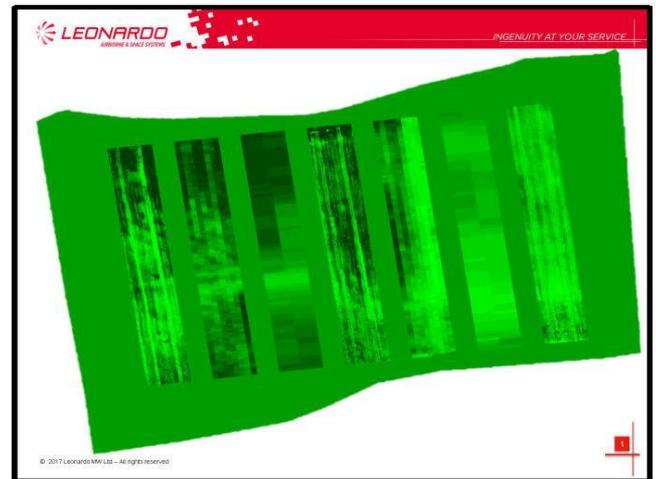
Enhancements to the prescription mapping can be achieved through the inclusion of additional field data such as soil electro conductivity, soil texture or soil zonal maps.

Overall, the trials showed that the use of targeted precision applications, based on Absolute Sense^{TM} detector technology, provides benefits to both farmers and the environment.