Knowledge grows

The Yara N-Sensor

Introduction

The improved Yara N-Sensor ALS-2 offers farmers a solution to real-time variable rate nitrogen applications by adjusting rates according to crop growth whilst travelling across a field. As a result the N-Sensor is designed to deliver precise levels of input according to the crop's requirements, helping to both reduce environmental effects whilst maximising potential profit.

A dedicated group of scientists at Yara's R&D base at Hanninghof carry out trial work annually to improve calibrations that exist currently and increase the range of options for use. As such the N-Sensor truly is backed by Science.

The result - improved gross margins and greater nitrogen efficiency.

Development

The Yara N-Sensor ALS-2 is the culmination of well over 20 years of development work at Hanninghof in Germany, through extensive testing and trial work.

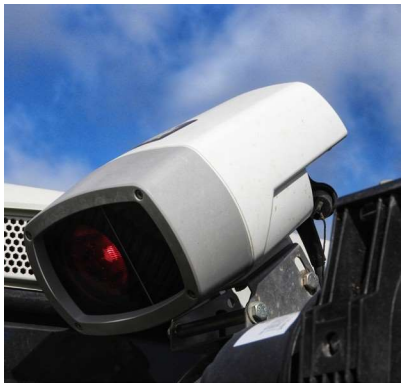
Originating from the first-generation Passive N-Sensor in 2005 the Active Light Source (ALS) was introduced as a solution to restricted working hours due to low or no ambient light. As the name suggests the ALS contains its own light source to continue operating irrespective of ambient light conditions.

In 2018 the ALS 2 was launched. During research and development, Yara had recognised the issue of damp leaves (dew) that affects all sensors and the reflectance accuracy achieved. Research was targeted to overcome this issue, culminating in the requirement to capture extra waveband data during sensing. This ‘dew suppression’ is unique amongst sensors and is a feature in the ALS 2 N Sensor. A new modular design and improved connectivity gives the ALS 2 more flexibility and easier mounting options.

Backed by Science

Trial work continues to be carried out annually at Hanninghof to progress the system further. Prior to the introduction of a calibration for a new crop, there are a large number of trials conducted to look at the nitrogen uptake of the crop in question and the effects of the interactions between different varieties and seed rates on the N-Sensor measurements at different stages of growth and the actual leaf nitrogen contents through laboratory analysis. Only once it is confirmed that there is a good correlation between the two will a new calibration for a crop be released.

Even for calibrations which are long established, work is carried out annually to fine tune them where necessary in order to continually improve accuracy.



How does the N-Sensor Work?

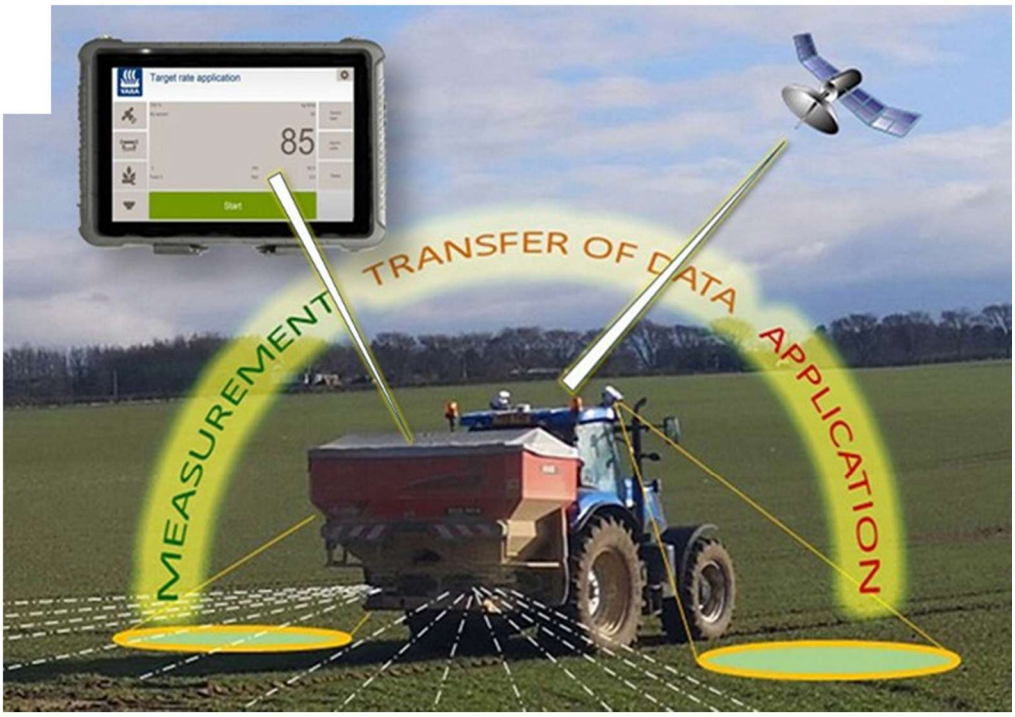
The N-Sensor determines the nitrogen demand by measuring the crop’s light reflectance covering a total area of approximately 50m2 / sec. Measurements are taken every second with the system designed to operate at normal working speeds and all bout widths. Most sensing technology applied to agriculture is based on the typical light reflectance curve for vegetation (NDVI). N-Sensor measures light reflectance at specific wavebands related to the crop’s chlorophyll content and biomass. It calculates the actual N-uptake of the crop. Optimum application rates are derived from the N-uptake data and sent to the controller of the variable rate spreader or sprayer, which will adjust fertiliser rates accordingly.

The whole process of determining the crop’s nitrogen requirement and application of the correct fertiliser rate happens instantaneously, with no time delay. This enables “real-time agronomy and application” to be possible.

N-Sensor: Remote crop sensing

Site-specific fertilisation is one of the main objectives of precision agriculture. Variable-rate nitrogen application requires accurate and efficient tools to determine the actual crops nitrogen status.

Remote sensing techniques offer the opportunity to deliver this information quickly, precisely, and cost-efficiently.The N-Sensor has been developed to determine the crop nitrogen status by measuring the Chlorophyl level of the crop and apply the correct amount of nitrogen to each part of the field without under or over application.



Why the N-Sensor ALS 2

Agronomic:

- Unique agronomically based, crop (wheat, oilseed, barley, maize, grass) specific algorithms
- Unique spectral indices to accurately 'sense' variable nitrogen supply throughout the main growing season.
- Clean, accurate 'sensing' with NO clouds, trees, landscape features to corrupt the data
- Unlimited scanning, day or night, NO waiting for satellites.
- Large 'scanning footprint' – up to 4.2m width each side of the sensor
- 4 wavelengths measured giving enhanced accuracy, suppressing the effects of damp leaves (e.g., dew)
- Apply the optimal nitrogen fertiliser rate to every part of the field
- Maximise the crop's potential across the whole field
- Increased yields and improved grain quality from more homogeneous crops
- Improved combine performance, reducing harvesting time and cost through more uniform crops

Environmental:

- Increase nitrogen use efficiency, reducing the risk of nitrogen losses to the environment
- Decrease nitrogen residues in soils post-harvest
- Reduces carbon footprints

Practical:

- Variable nitrogen applications from simple 'switch on and go', to more complex precision mapping and data management.
- Lightweight for easier, safer fitting.
- Modular design for more flexibility in fitting
- LAN connections enable greater distances between sensor heads when mounting.

- Comparison between standard farm practice and Absolute-N

		Yr 1	Yr 2	Yr 3	Average
Yield (t/ha)	uniform	3.37	4.59	3.82	**3.93**
	N-Sensor	3.55	4.87	3.82	**4.08**
N fertilizer rate (kg N/ha)	uniform	178	156	170	**168**
	N-Sensor	150	182	91	**141**
Revenues (£/ha), N cost considered *	uniform	£66	£1,129	£900	**£1,224**
	N-Sensor	£844	£1,182	£979	**£1,301**
N balance (kg /ha)	uniform	67	5	44	**39**
	N-Sensor	33	21	-35	**19**

Modes of Operation

N Application

This calibration is the original which requires a reference scan to be conducted from an average area of the field and entered before beginning the fertilizer application.

Target Rate

Target rate was introduced to speed up the calibration process and allows a rolling calibration during operation, whereby the reference value is calculated from the moment the sensor starts taking measurements on the field.

Both operation modes allow reference or target N rates to be assigned as well as fixing MAX & MIN to control the range of adjustments possible. The reference or target rate is essentially the average rate to be applied to the field and should be calculated before entering the field. The N-Sensor will then vary around this average depending on measurements from the crop.

Absolute N on OSR & WW

The Absolute N calibration introduced in 2010 for OSR and then developed for WW in 2018. In this mode, rather than calculatingthe amount of N to apply before getting
to the field, the N-Sensor makes the recommendation at the point of application.The N-Sensor measures the N picked up in the crop for the given growth stage and knows the expected amount of N required by the crop at that timing and then applies or cutback the difference.

Other parameters are required during the setup to help calculate the appropriate rate of N to apply, including dead biomass and mineralisation potential.

Grassland Application

Based on experiences with N-Sensor measurements in Nordic grass fields, the N-demand in grassland can vary 80 kg N/ha, from the lowest to the highest point. With the Yara N-Sensor, nitrogen is optimized for DM yield and the profit is estimated to 40-68 £ per hectare.

The Yara N-Sensor grassland calibration is developed for cut systems for forage production (pure ryegrass or mixed swards, typically meadow fescue and timothy). High clover content affects the measurements and should not exceed 20% content. The oblique angle of Yara N-Sensor is especially beneficial to avoid the effect of clover or weeds.

Potato Haulm Killing

An under-license module from Plant research International in the Netherlands for site specific dosing of potato desiccants. By measuring the reflectance of the potato canopy, it is possible to pick up differences incolour significantly in advance of the humaneye, therefore applying higher dose rates
to the ‘greener’ canopies to improve the uniformity of action and help reduce overall herbicide us.

Biomass Cut-Off

For all the modes a biomass cut-off value is required during the setup which will vary according to the growth stage of the crop. This instructs the N-Sensor to cut back to the minimum application rate when the biomass measurements falls below the entered value.

This ensures N is not wasted on areas of the field which are unlikely to yield due to pest damage, waterlogging etc.

An Agronomy Tool & Scanning

The N-Sensor operates with GPS mapping to enable customers to create biomass and N application maps for each field scanned. These maps are a useful agronomy tool highlighting areas of low biomass which enable the user to go back and gather more information as to the cause of the problems. They can also be matched with yield maps to help identify reasons for high or low yielding areas and can also be useful for traceability records for Crop Assurance Schemes.

It is recommended that even when not applying N, to scan crops with the Sensor, especially at crucial growth stages.

Benefits of the Yara N-Sensor™

N-Sensor Tablet

All new N-Sensor installations come with a tablet PC which runs the software and links to the rate controller. This tablet records Biomass and N applied maps (in most cases).

Improved Yield - Improved Gross Margin

The single biggest benefit from using the N-Sensor is also the hardest to measure, however Yara have conducted a large number of trials over the years looking at the yields of uniform compared to variably applied N in the UK and throughout Europe.

Comparing the use of the N-Sensor to uniform application 82% of the trials showed an advantage.

The average yield increase compared to uniform application was 3.2% with a maximum of 12% on some trials.

Analysis has shown that where fields contain higher levels of variability due to changing soil types, manure application or topography, the benefit obtained from variable N application using the N-Sensor was at its greatest.

Reduced Lodging

One of the most common benefits seen by customers is the reduction in lodging from using the N-Sensor. Over application of N can result in crop lodging, which can have dramatic effects on profitability through reduced yield, quality and increased harvest time and drying costs.

Lodging in OSR in particular as a result of too dense a canopy, can have a severe impact on yield with losses of up to 30% possible.

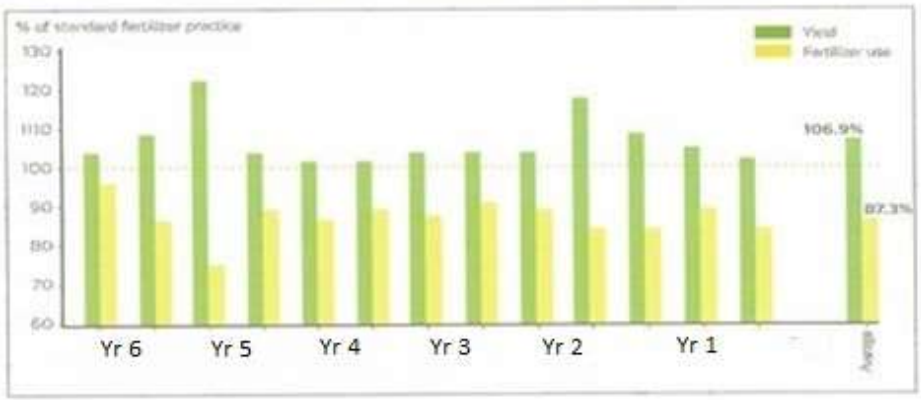
Improved Combine Performance

Greater crop evenness achieved by usingthe N-Sensor also results in more even ripening enabling faster harvesting and reduced drying times. In trials between 2002 - 2004 improvements in combine output showed output increase of 10% to26% across the trials with an average of 18.5%, reducing the number of harvest days required.

Even Grain Quality

By applying the crop's optimum N requirement in all areas of the field, the N-Sensor has the effect of helping to reduce variability in yield and grain quality over the field. A trial carried in 2002 looking into the application of late N in winter wheat showed that the variability in protein was reduced by over 60% were the N-Sensor was used, compared to uniform application.

Figure 12. Comparison of N-Sensor use against standard farm practice



Summary

- The N Sensor ALS was awarded the RASE Gold Medal in 2008
- Cereal yields increased by 3.5% where the same intensity of fertiliser was used
- Oilseed yields increased by 3.9% through the Absolute-N calibration
- Nitrogen savings of up to 14% have been recorded where N Sensor was used
- Increases in nitrogen use efficiency have reduced the carbon footprint by 10-30%
- Combine performance was increased by 12-20% due to reduced lodging, lower losses, and faster intake speeds
- Protein levels in cereal crops showed greater consistency averaging 0.2-0.5% above target
- An 80% reduction in lodging rates (compared with crops where nitrogen was applied under conventional practices)
- The first nitrogen sensor to have 'dew suppression' to further improve sensing accuracy.

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About Yara

Yara's knowledge, products and solutions grow farmers and industrial customers' businesses profitably and responsibly, while nurturing and promoting the earth's resources, food and environment.

Our fertilizers, crop nutrition programs and technologies increase yields, improve product quality, and reduce environmental impact from agricultural practices. Our industrial and environmental solutions reduce emissions and improve air quality from industry and transportation, and serve as key ingredients in the production of a wide range of goods.

Founded in 1905 to solve emerging famine in Europe, Yara today has a global presence with more than 12,000 employees and sales to more than 150 countries. **www.yara.com**