Precision farming for sustainable agriculture

WHEN LESS IS MORE

Nitrogen fertilizers are a vital ingredient for modern agriculture and world food supply. But excess amounts of fertilizers have a negative impact on the environment. Minimizing input whilst maximizing output is a winning strategy from both an economic and ecological perspective.

Yara precision farming tools allow farmers to adjust fertilization to the exact needs of plants at every spot on the field.

YARA

Knowledge grows

Farming tomorrow

Producing more food with ever less environmental impact will be one of the challenges for tomorrow's agriculture. Over the last few years, a great deal of work has gone into understanding and tackling environmental issues, and European farmers are at the forefront of sustainable agriculture.

Can nitrogen use efficiency be further enhanced? How to meet European policy objectives on emission control? Are there ways to reduce fertilizer input while increasing profit?

DETERMINING PLANT NEEDS

Determining the right amount of fertilizer to apply with the right timing has considerable impact on yield, protein content, fertilization cost and the environment. But assessing actual plant needs depends on a number of factors. Some of them can vary significantly even on a very small scale and within a short time frame. And not all of them can be easily detected by visual appearance:

- Field topography as well as differences in soil structure have an impact on nutrient availability and water supply
- Yield expectations, and thus nitrogen budgets, evolve throughout the season
- The soil nitrogen supply depends on temperature, humidity and carbon content
- Previous applications of organic fertilizers increase the uncertainty and heterogeneity of soil N supply even further

ACCOUNTING FOR IN-FIELD VARIATIONS

Current best farming practice uses nitrogen budgets to account for yield expectations, soil nitrogen supply and possible other nitrogen inputs such as manure. Split application ensures that applied nitrogen is not lost but taken up quickly.

There is a thin line between under- and over-fertilization. Yield losses and environmental burden rise sharply on either side of the border. Nitrogen budgets are generally established as a per field average. In reality, however, nitrogen needs vary on a significantly smaller scale. Applying a uniform quantity of nitrogen leads to under-fertilization in some plots, limiting yield and protein content. In other plots, the applied nitrogen exceeds plant uptake and is lost. Taking into account in-field variations of nitrogen need reduces fertilizer input, creates a more uniform crop stand and enhances overall yield and crop quality.

PRECISION FARMING

Precision farming tools aim at assessing a crop stand's nitrogen uptake in real time, parcel by parcel, and to adjust fertilizer application accordingly. Different technologies are available and in use, from remote satellite imaging to close-up optical analysis.

Yara precision farming technologies determine chlorophyll and biomass density by on-spot optical measures. Unlike satellite imaging, they are independent from weather conditions and external data providers, thus offering full control to the farmer. Desktop software tools assist farmers in making best choices and in keeping records up to date.

YaraPlan™ *is a desktop system that establishes detailed nutrient budgets and recommendations according to official guidelines. The system offers integral nutrient evaluations and can be used for documentation.*

Yara N-Tester *is a handheld device. It determines nitrogen requirements by measuring the chlorophyll content of the leaf. The device is calibrated for different crops and growth stages.*

Yara N-Sensor™ *determines actual nitrogen requirements by optical means and controls the spreader in real time. When connected to a GPS receiver it can automatically generate maps of crop density, nitrogen requirements and fertilizer spread.*

Yara N-Sensor™ ALS *(Active Light Sources) features build-in lighting, enabling low light and night time operation.*

Enhancing yield and crop quality

Precision farming tools help farmers to tailor fertilizer applications to plant needs with much higher precision than ever before. Accounting for variations of nitrogen requirements within a field creates more homogeneous crop stands with less lodging, increases yield and quality, diminishes fertilizer input, reduces cost and keeps environmental burden down to a minimum.

What benefit can farmers expect in practice? Can savings be quantified? Field trials conducted by Yara and others provide an answer.

FINE TUNING NITROGEN APPLICATION

A series of 240 field trials in France compared fertilization assisted by N-Tester to fertilization according to conventional nitrogen budgets over a period of 8 years. Optimum decisions increased from 38 % of cases to 61 % (figure 3) by using the N-Tester.

IMPROVING NITROGEN USE EFFICIENCY

When comparing sensor-controlled fertilization with uniform application in large scale field trials in Germany over 5 years, sensor-controlled fertilisation increased yield by 6 % and reduced nitrogen application by 12 % on average. Revenue increased by 57 €/ha (Table 1).

REDUCING LEACHING

Winter rape is a valuable crop and an excellent preceding crop for cereal rich rotations. Winter rape, however, has a comparatively low N efficiency and can leave high levels of residual mineral nitrogen in the soil upon harvest. The excess nitrogen is prone to leaching (see pure nutrient facts n° 2). Intelligent N fertilisation and precision farming help to reduce the excess N-balance while saving cost (Table 2).

The Yara N-Sensor™ determines optimum fertilization rates from the difference between the currently measured N uptake and the N uptake needed for the expected yield.

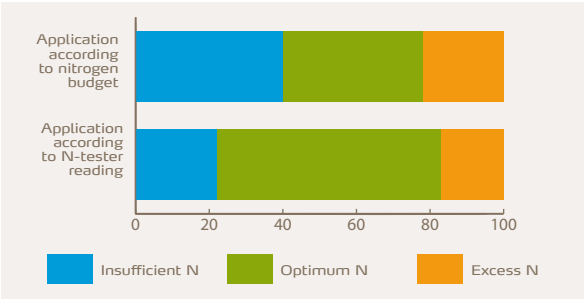

Figure 3: N-Tester reduces the cases of under- and over-fertilization compared to nitrogen budgets [6].

	Trials	Yield	Fertilizer	Gain
2001	8	+4 %	-9 %	42 €/ha
2002	8	+4 %	-11 %	41 €/ha
2003	2	+10 %	-9 %	90 €/ha
2004	2	+7 %	-14 %	62 €/ha
2005	4	+5 %	-13 %	50 €/ha
Mean	**24**	**+6 %**	**-12 %**	**57 €/ha**

Table 1: Field trials in Germany [5]. N-Sensor™ - controlled spreading increased yield while fertilizer input diminished. An average gain of 57 €/ha at actual wheat prices during the period could be achieved by sensor-controlled spreading.

	Uniform	N-Sensor™	
Yield t/ha	3,98	4,21	+5,8%
N supply kg N/ha	167	166	-0,6%
Revenues €/ha	895	953	+6,5%
N balance kg N/ha	36	27	-25%

Table 2: N-Sensor™ based variable rate fertilisation of winter oil seed rape compared to uniform application. Results from field trials in Germany in 2004 and 2006 [4].

REDUCING LODGING

Over-fertilization during leaf emergence results in increased risk of crop lodging. Late, light lodging reduces yield by 5 to 15 %, the falling number by 10 to 15 % and the sedimentation value by 5 to 10 % [1]. Harvesting costs can increase by 200 to 300 % in case of severe lodging [2].

Growth regulators are used to avoid lodging. With the Yara N-Sensor™, haulm stabilisers are applied intelligently: vigorous plant stands need maximum protection and obtain higher doses. Thin, sparse and stressed plants get only slight, if any protection.

In a large scale trial on a 100 ha field in the loess-hill area of central Saxony, the interaction of sensor-controlled fertilisation and growth regulator application was investigated. In figure 4, the zones with lodging can be identified by their brighter colour. Parcels marked in green correspond to sensor-controlled fertilisation and parcels marked in yellow correspond to uniform fertilisation. Lodging could be reduced from 29-32 % to 3-5 % through sensor-controlled fertilisation. The yield increased.

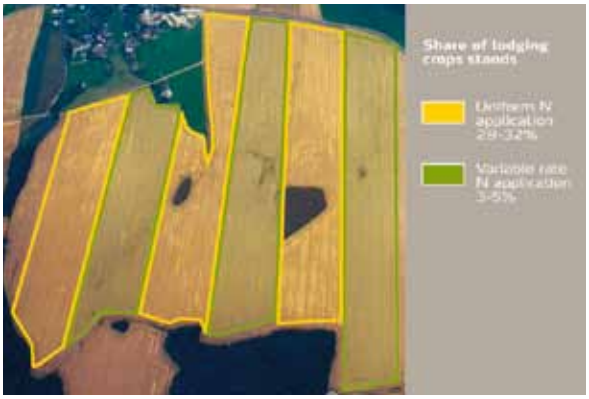

Figure 4: Strip trial with uniform (yellow) and N-Sensor™ controlled (green) N fertilization (2004). N-Sensor™ use reduced crop lodging (areas with a bright coloured crop) significantly [4].

IMPROVING THRESHING

Combine drivers know that sensor-fertilised crop stands are easier to harvest. Large scale field trials, conducted from 2002 to 2004 in Germany, have confirmed the effects of the N-Sensor™ on the threshing characteristics of cereals.

Sensor-controlled fertilization increases performance of the combine harvester on average by 9 to 33 % compared to uniform fertilisation [3].

In 2004, detailed analysis of the trial results showed a yield increase by 4 % and an impressive reduction of the combine's fuel consumption by 17 % (Table 3).

The reasons for this increase in performance are:

- more homogeneous crop density (ears/m²)
- uniform growth height
- better and more even ripening
- better cut

Enhanced threshing performance means higher strike force. At the same time, the harvesting window is enlarged. Sensor-fertilized crops can be harvested 3 to 5 days earlier and up to 2 days later. The daily threshing time also increases. Homogenised stands dry more quickly in the morning and moisten less quickly in the evening.

	Performance increase		Yield increase	Fuel economy
	Date 1	Date 2		
variety 1	22 %	15 %	3,8 %	30 %
variety 2	43 %	14 %	5,5 %	6 %
variety 3	13 %	8 %	2,1 %	14 %
Mean	**26 %**	**12 %**	**4 %**	**17 %**

Table 3: Threshing trials in Germany conducted in 2004 as a joint project with the Harvestpool (including John Deere, BASF, Saaten Union and Feiffer-Consult) demonstrated enhanced threshing performance with sensor-controlled spreading [4].

N-Sensor™, how does it work ?

The N-Sensor™ is the fruit of agronomic and technologic research performed at the Yara Research Center in Hanninghof, Germany. More than a thousand Yara N-Sensor™ units are currently in use throughout the world. Farmers chose the N-Sensor™ for its reliability and documented benefit. But how does it actually work?

WORKING PRINCIPLE

The Yara N-Sensor™ is an optical device. It measures light reflectance from the crop canopy in different spectral ranges, using either ambient light (classic N-Sensor™) or in-built light sources (N-Sensor™ ALS). The system is designed to work continuously at normal tractor speed, scanning two strips of approximately 3 meters width on both sides of the tractor. The N-Sensor™ provides reliable and representative readings. The artificial light sources on the N-Sensor™ ALS make it suitable for nighttime operations.

The measured reflectance contains information on chlorophyll content and biomass. Both indicators are used to calculate nitrogen uptake and optimum application rates. The information is sent to the spreader controller. Spreading rate is adjusted instantaneously to actual crop needs.

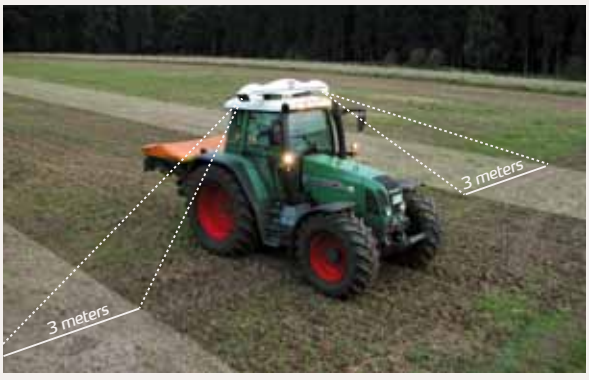

Figure 1: N-Sensor™ ALS - viewing geometry and footprint

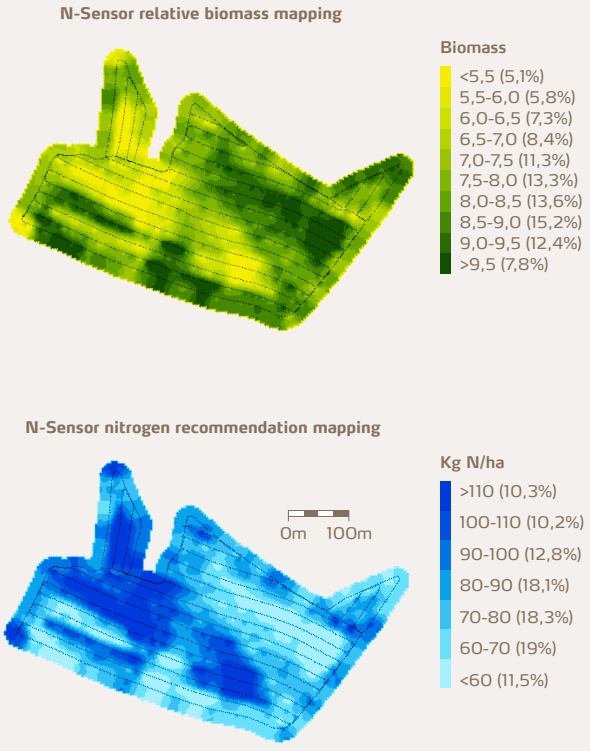

Figure 2: N-Sensor™ maps showing in-field variability of sensor readings and recommended nitrogen fertilizer rates

Optimizing yield, preserving the environment

Nitrate-based fertilizers - such as ammonium nitrate, calcium ammonium nitrate and nitrate-based NPK compounds - are pure nutrients offering the required precision, efficiency and reliability to meet the agronomic and environmental imperatives of sustainable agriculture. Yara nitrate-based fertilizers ensure precise spreading, fast plant uptake and low losses. They are the natural choice for farmers who want to apply precision farming.

UREA OR AN?

Precision farming tools can be used with all types of nitrogen fertilizers. They enable fertilizer savings, ensure uniform crop growth and increase yield as well as crop quality. Precision farming makes most sense, however, with fertilizers that offer the highest spreading precision, fastest uptake and lowest losses – such as ammonium nitrate.

Urea-based fertilizers are subject to unpredictable volatilization losses and spread less evenly. In addition, plant uptake is slower. This is the reason why Yara recommends nitrate-based fertilizers in conjunction with its precision farming tools.

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For further information about nitrate fertilizers, get the complete nitrate fertilizer brochure from www.yara.com

LITERATURE

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ABOUT YARA

Yara International ASA is an international company headquartered in Oslo, Norway. As the world's largest supplier of mineral fertilizers for more than a century, we help to provide food and renewable energy for a growing world population.

Yara provides quality products, knowledge and advice to farmers. Please do not hesitate to contact one of our local agronomists for further information.

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