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N-Sensor ALS® – Basics, Application and Use

Based on the well-known and practice-proven Yara N-Sensor®, a new active crop sensing system "Yara N-Sensor ALS®", equipped with a built-in artificial light source, for site-specific optimisation of nitrogen fertiliser application has been developed. The system can operate during the day as well as during the night, independent of ambient light conditions, and hence allows for considerable extension of the application time of the N-sensor technology.

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In the previous years site specific nitrogen application has been more and more established in agricultural practice. The Yara N-Sensor, commercially available since 6 years, has largely supported this process. Results from several years have shown that N-Sensor based variable-rate nitrogen application increased the yield, reduced lodging and made harvesting easier and more cost-effective [1].

However, the disadvantage of the existing N-Sensor technology was that due to its measuring principle it required a minimum amount of daylight, which limited the use of the system to a time frame of approximately 8 to 10 hours per day. To overcome this restriction, a new "active" reflectance sensor has been developed (*Fig. 1*). This device contains its own light source, allowing measurements independent of daylight. As with the conventional system, the spectral reflectance of the crop is measured, but instead of ambient light the light of a flash lamp is used to illuminate the crop.

Requirements for an active system

Based on the experience with the "passive" N-Sensor, specific requirements for the new system were identified. It was regarded as essential to scan a representative fraction of the working width, i. e. the working width should not be less than with the passive system (two strips of 3 m width on each side of the tramline). In the same way, it has been proven successful to measure from the roof of the vehicle without the need for additional booms to carry the sensors close above the canopy. Furthermore, the reflectance should be measured in certain spectral wavebands, which are considered as optimal for crop sensing. All this requires a spectrally broadband, modulated high-energy light source together with a very sensitive detector, which is capable to detect the relatively weak reflectance signal in front of the possibly very strong solar irradiance background.

Fig. 1: N-Sensor ALS

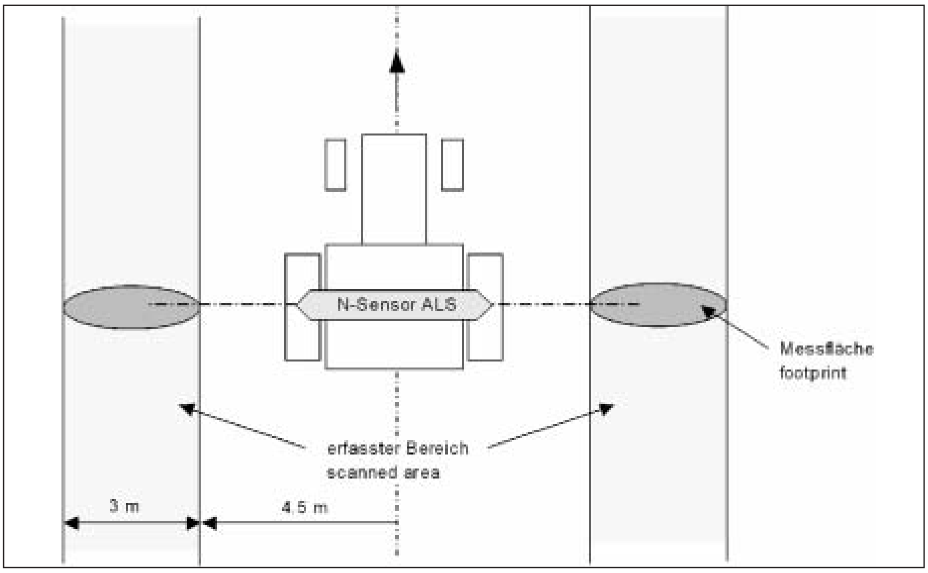

Fig. 2: Viewing geometry of the N-Sensor ALS

System layout and viewing geometry

The general system layout has been unchanged to the conventional passive system. The processor, the wiring, the operating terminal and most of the operation software have been adopted from the existing system. As a result, for the end-user there are no differences between both systems concerning starting up, operation and practical use.

However, the measuring heads have been re-designed completely. Each system contains two of those heads, one for the left and one for the right side of the tramline, respectively. Each head points to the crop at an oblique view of 58° from nadir and covers a long, elliptical footprint (*Fig. 2*). At a typical mounting height of 3 m this footprint is approximately 3 m wide vertical to the driving direction and 70 cm long in driving direction. When moving across the field, a continuous strip of 3 m width is scanned on both the left and the right side of the tramline. Once per second the target application rate is calculated from the readings and sent to the variable-rate spreader or sprayer. As with the passive system, spreaders and sprayers from all major manufacturers can be controlled.

Sensing heads

A single sensing head is shown in *Figure 3* schematically. It contains both the light transmitter and the receiver. The transmitter comprises a xenon flash lamp with a flash frequency of 20 Hz and maximum pulse energy of 500 mJ per flash. A high-pass filter blocks all wavelengths below 650 nm. As a result, only a faint red light is visible to the human eye. Furthermore, cylindrical lenses are used to create the long elliptical footprint.

The receiver consists of four identical channels including optics, interference filters and photo diodes. Its optical axis is nearly parallel to the optical axis of the transmitter and the footprint is identical to the area illuminated by the flash. The interference filters determine the wavelengths of the individual channels. Band-pass filters with 730, 760, 900 and 970 nm center wavelength are used. These wavebands have been identified as optimal for determining the nutritional status of the crop [3].

At the same time when a flash is released, the detector is activated to measure the sum of the flashlight and the ambient light. A second measurement is carried out immediately after that when the flash is off, detecting only the ambient light. Subtracting both signals from each other leads to a signal which is solely induced by the flash and therefore completely independent of ambient light conditions. The system works as good in the night as in broad sunlight.

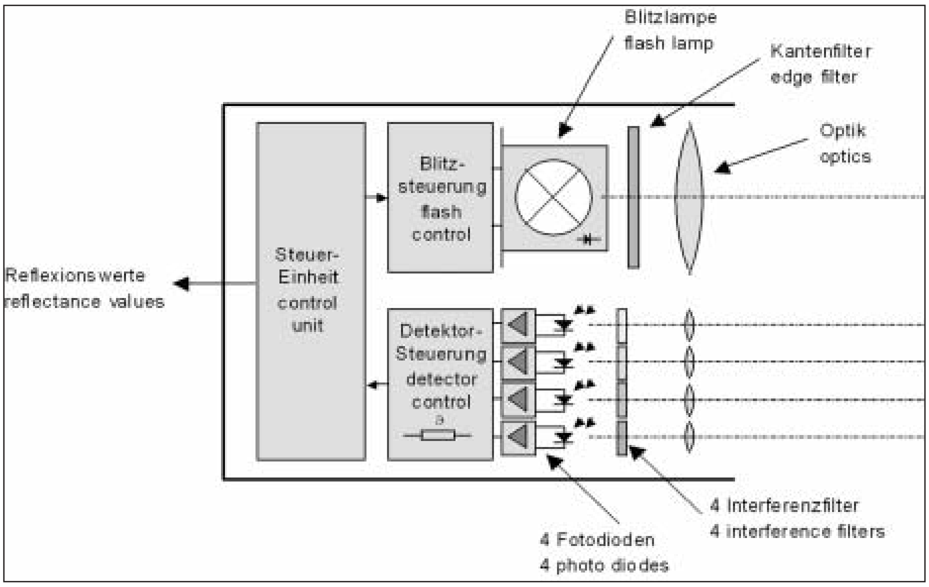

Fig. 3: Measuring head

Data processing

As with the passive system, N-Sensor ALS users have free access to the *SensorOffice.com* internet-platform for data processing. Application rates and sensor readings recorded during N-Sensor application can be converted into a printable map very easily and very quickly.

Practical experience

The N-Sensor ALS has successfully proven its performance in the spring season 2005 on approximately 200 farmer's fields. For the 2006 fertilizer season it is now commercially available. As the measured spectral reading ("sensor value") is comparable to the reading from the passive unit and as the agronomic algorithms have been unchanged, all known advantages experienced with the passive system (see [2]) can be directly transferred to the new N-Sensor ALS.

Literature

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