N-Sensor ® based variable rate nitrogen fertilization

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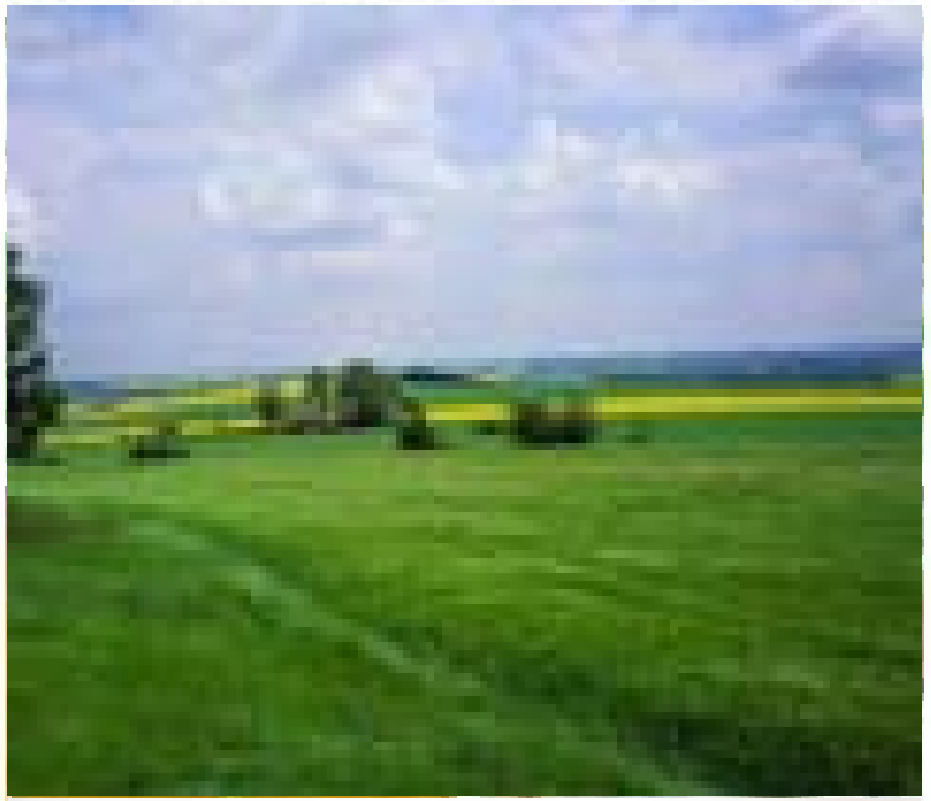


Background

Heterogeneous fields are the rule – variable rate N fertilization is a logical consequence

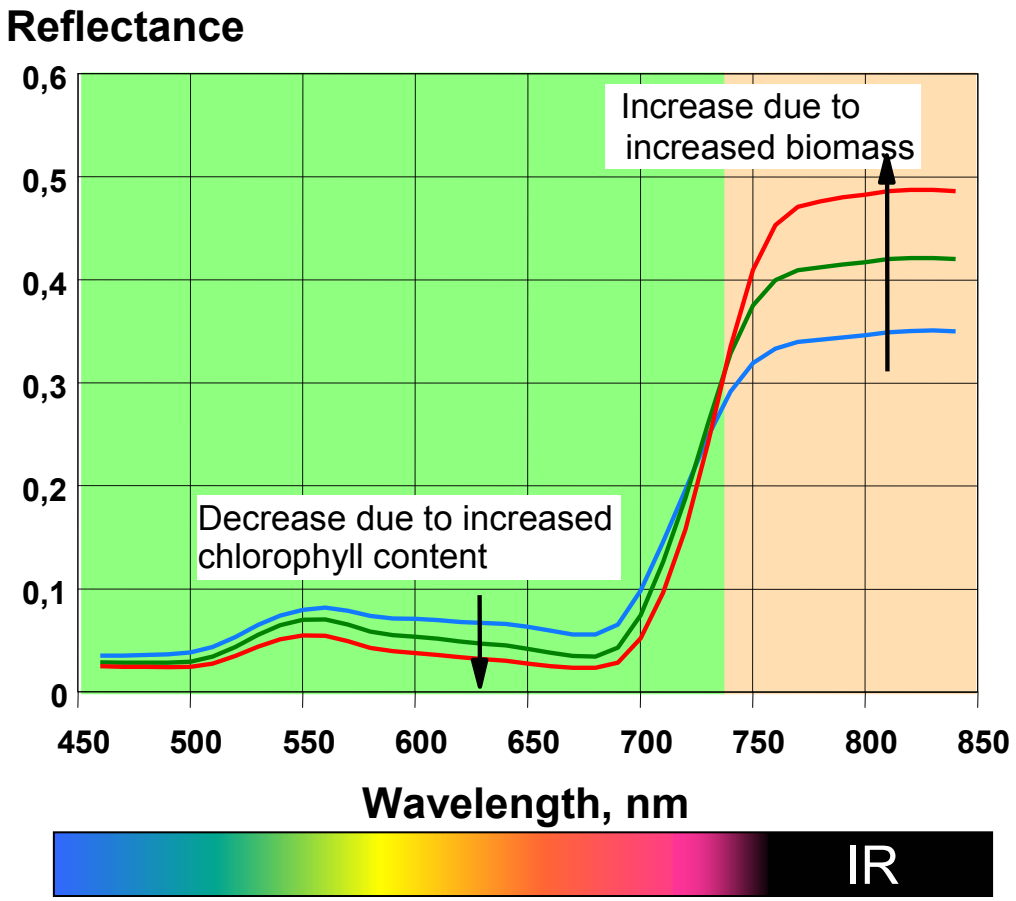
Technology

N-Sensor®


Picture: Agri Con GmbH

- Plant nutrition know-how & sophisticated hardware
  - Development based on an agronomic concept for site-specific plant nutrition
  - Powerful sensor hardware
    - Greater distance from sensor to crop, oblique view, large footprint
    - Optimized vegetation indices for reliable N status discrimination in dense crop stands
  - Crop and growth stage specific fertilization algorithms (developed in field trials)

Light reflectance from crop canopies gives information on the crop's N nutrition status



N Supply

200 kg/ha

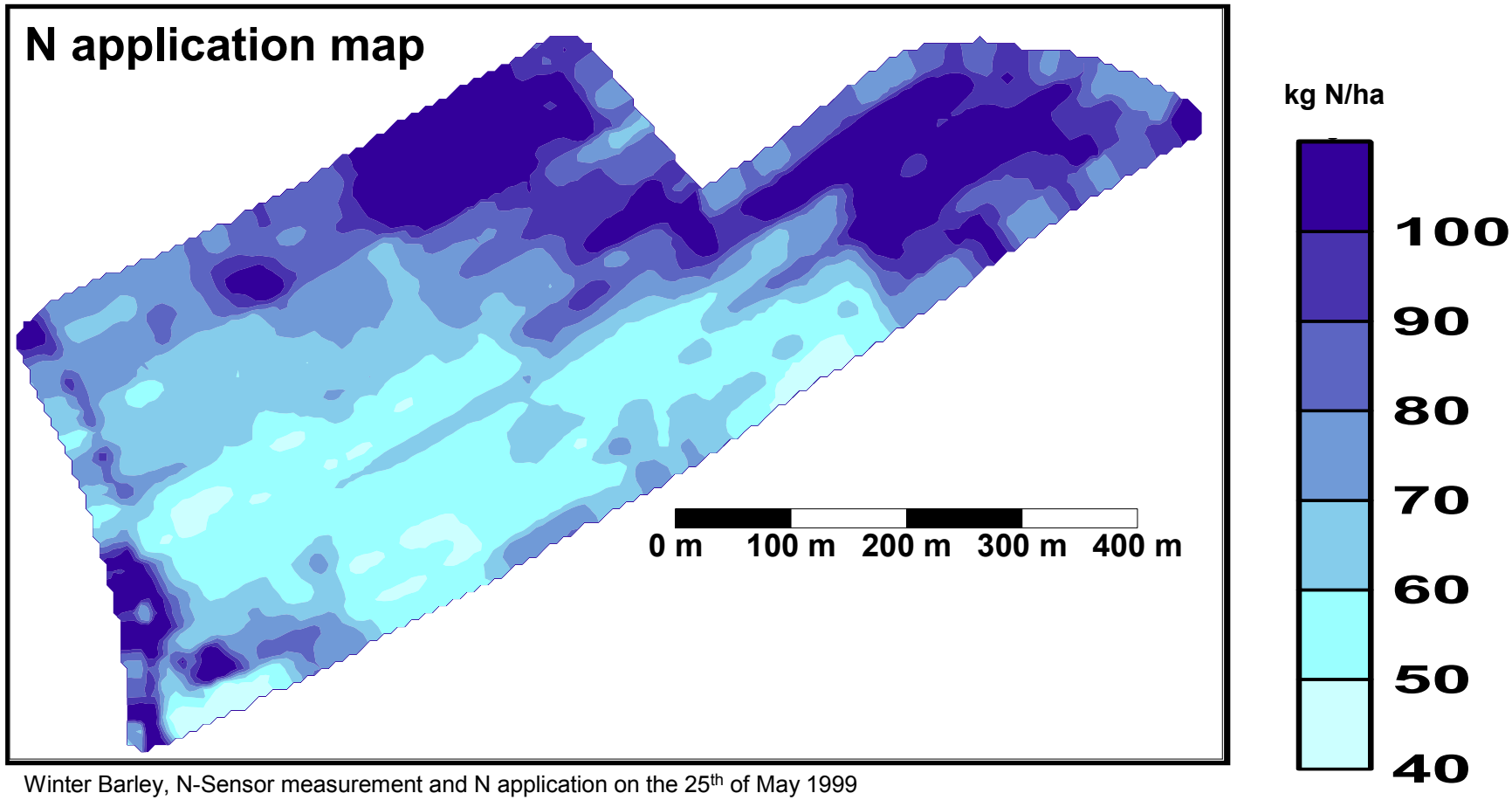
120 kg/ha

60 kg/ha

N response trial, 1994, winter wheat

➔ **N status of crops can be measured by analysing spectral reflectance data**

N-Sensor® detects areas of different N supply and adjusts N fertilizer rates accordingly

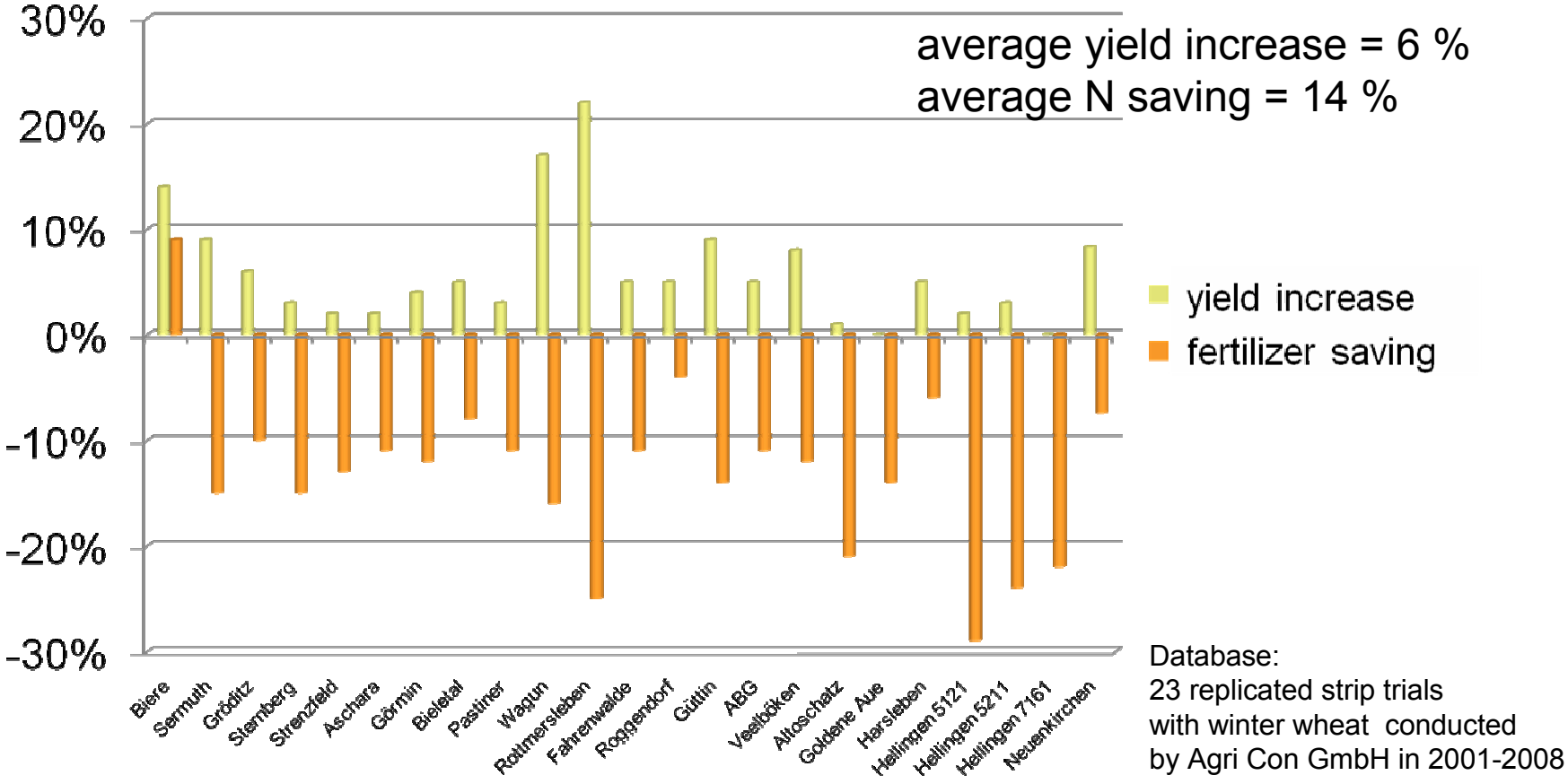


Winter Barley, N-Sensor measurement and N application on the 25th of May 1999
Source: AgriCon, Germany

Benefits

N-Sensor® based variable rate N fertilization increases N use efficiency

Yields and N rates of variable rate N treatments (N-Sensor calibrated with N-Tester) as compared to uniform N treatments fertilized according to farm practice



Database:
23 replicated strip trials
with winter wheat conducted
by Agri Con GmbH in 2001-2008

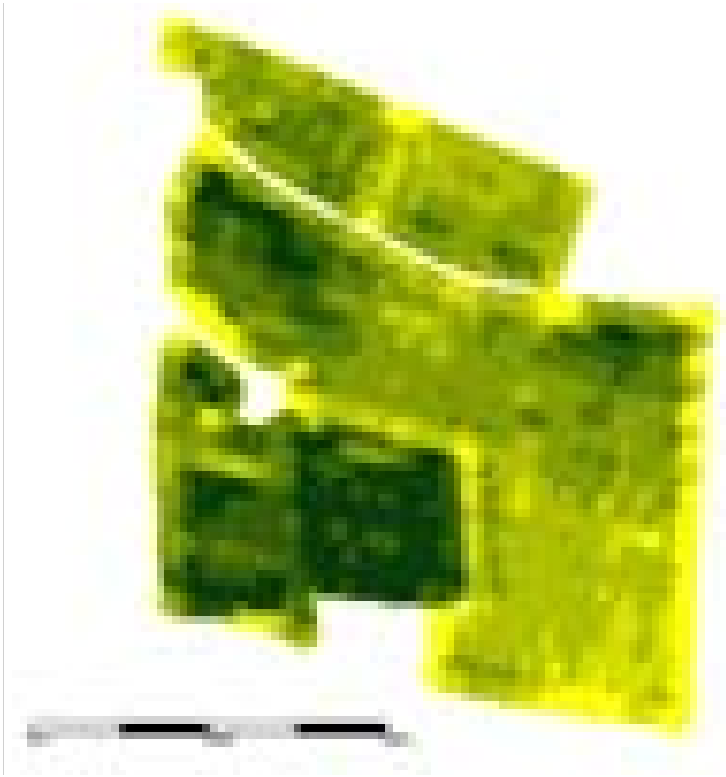
Effects of N-Sensor® based variable rate N application (field trials, on-farm research)

Resulting economic benefit:
50 – 100 €/hectare,
depending on in-field variability, grain and fertilizer prices

Agronomic calibration

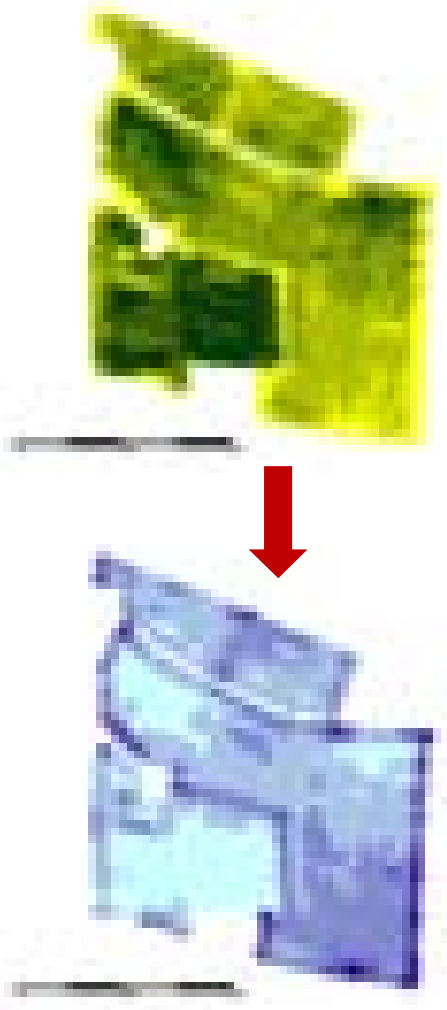
Crop sensors provide “colourful maps” with limited information

- Crop sensors generate dimensionless readings
  - Optical sensors: spectral indices (vegetation indices) related to the chlorophyll amount in the crop canopy
- The relationship between the sensor reading and the measured plant parameter is not quantified
  - Neither absolute values for the plant parameter nor quantitative differences of that plant property within the field can be derived from the measurement
- Sensor maps show qualitative differences of plant parameters within a field
  - more - less - equal



Converting a “colourful map” into a fertilizer recommendation

- **Which plant parameter to be measured?**
  - Which is the most suitable crop property to be used?
- **Calibration of the sensor reading?**
  - Relationship sensor reading/crop parameter → sensor value
  - Impact of crop species, cultivar, growth stage
- **Fertilization algorithms (decision rules)?**
  - Relationship sensor value/optimum N rate

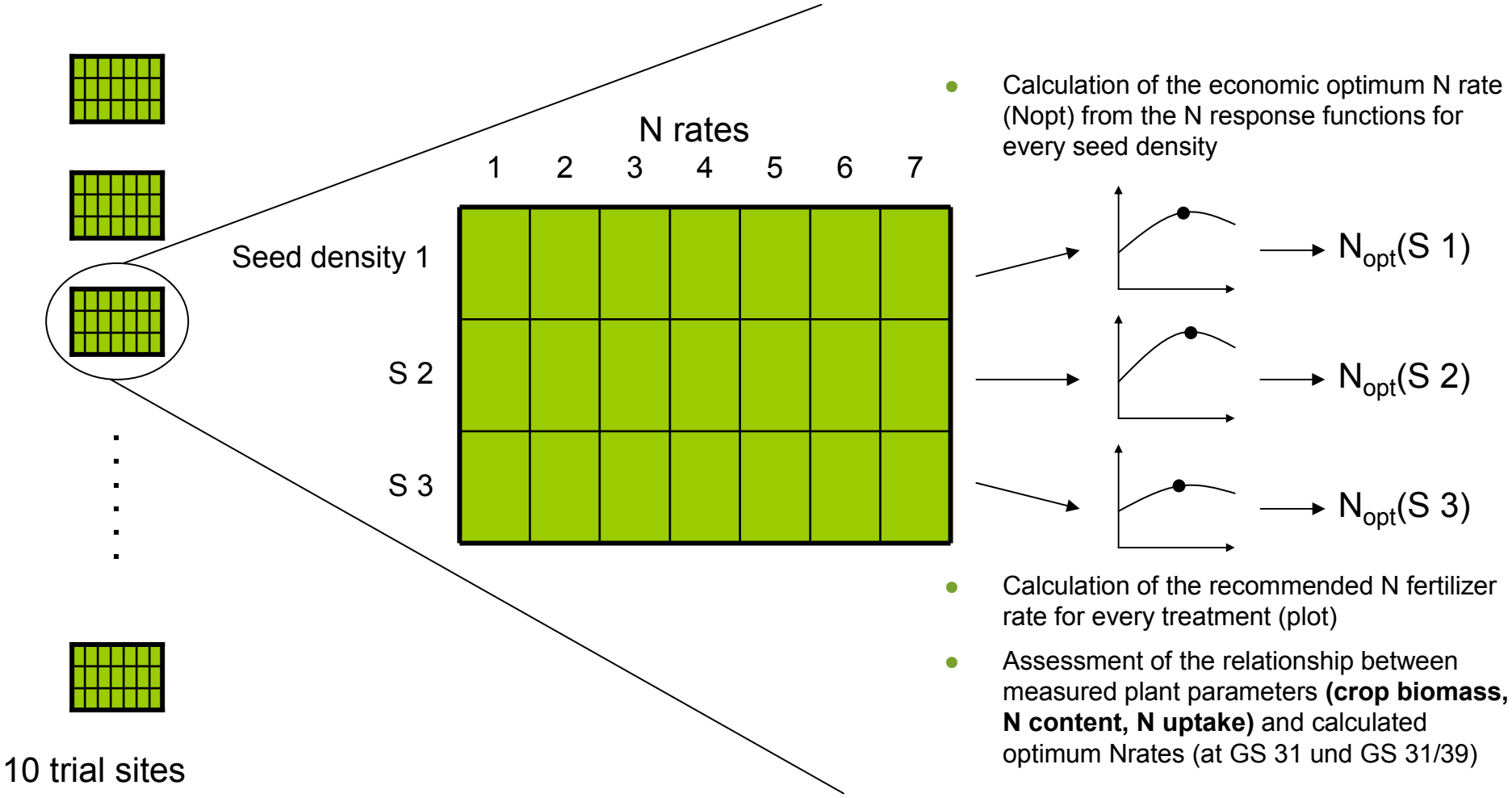


Which plant parameter to be measured?

Which is the most suitable crop property to be used for the derivation of site-specific N fertilizer recommendations?

Foto: www.luftbild-auto.de

Which is the most suitable crop property for the derivation of site-specific N recommendations?



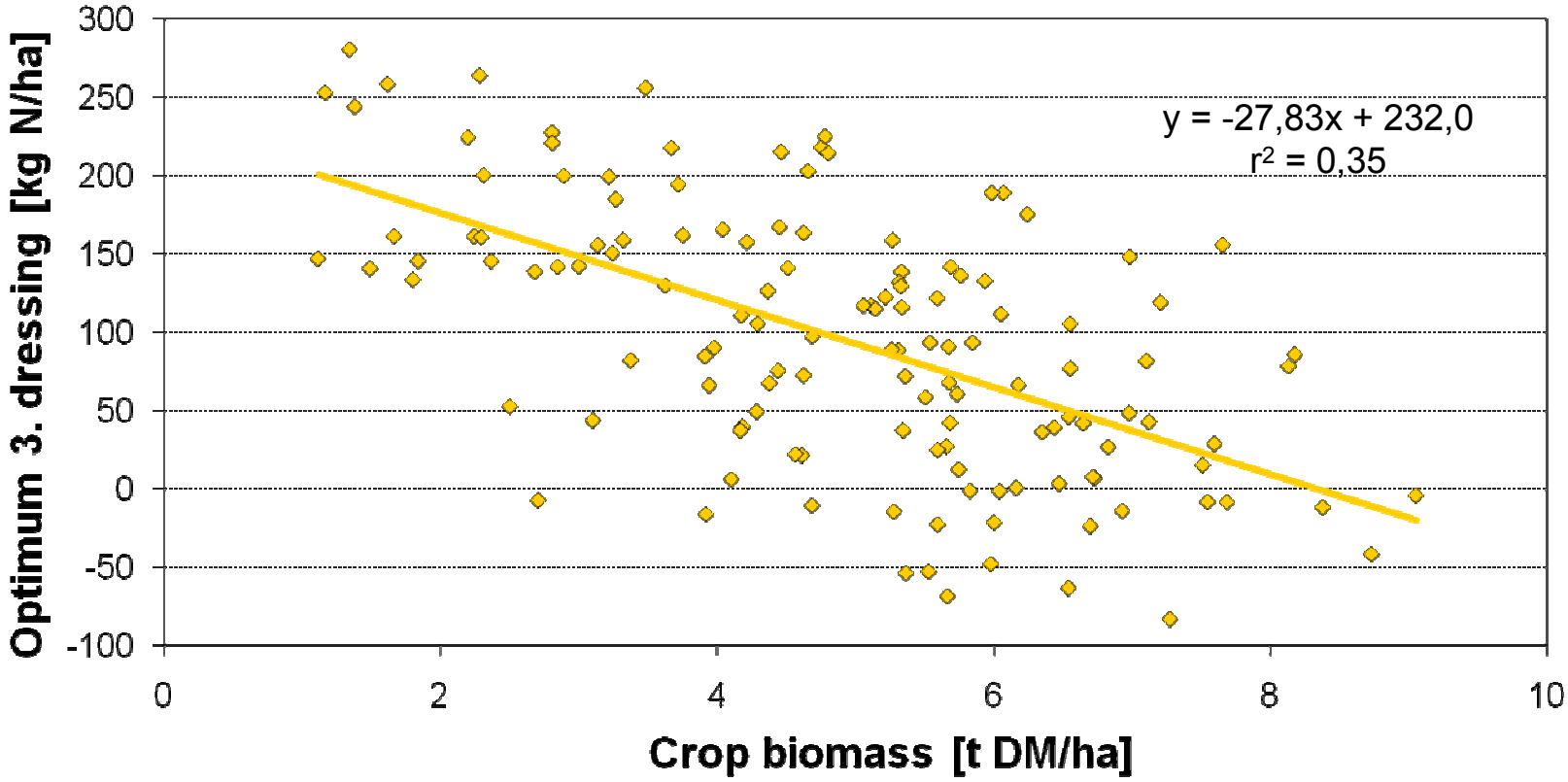
- Calculation of the economic optimum N rate (Nopt) from the N response functions for every seed density
- Calculation of the recommended N fertilizer rate for every treatment (plot)
- Assessment of the relationship between measured plant parameters **(crop biomass, N content, N uptake)** and calculated optimum Nrates (at GS 31 und GS 31/39)

Differentiated crop stands

Seed density
360 seeds/m²

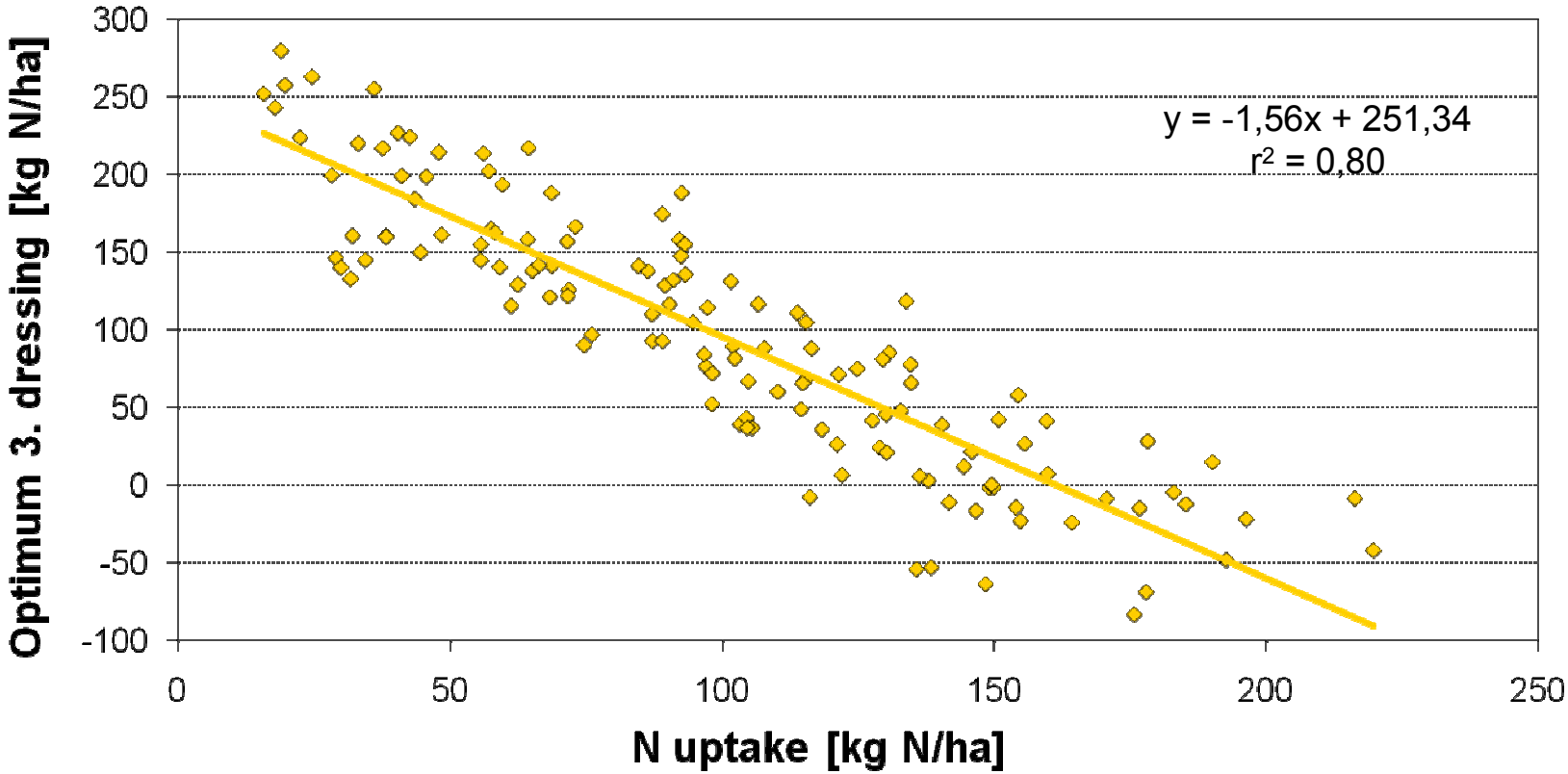
Seed density
60 seeds/m²

Relationship between crop biomass and optimum N fertilizer rate (3. N dressing)



- Measurement of crop biomass does not take differences of N content into account. The suitability of crop biomass measurements for the derivation of optimum site-specific N rates is therefore limited ($r^2 = 0,35$).

Relationship between crop N uptake and optimum N fertilizer rate (3. N dressing)



- Measurement of crop N uptake is most suitable for the derivation of optimum site-specific N rates ($r^2 = 0,80$). Crop density (biomass) is considered as well as the N content of the cropt.

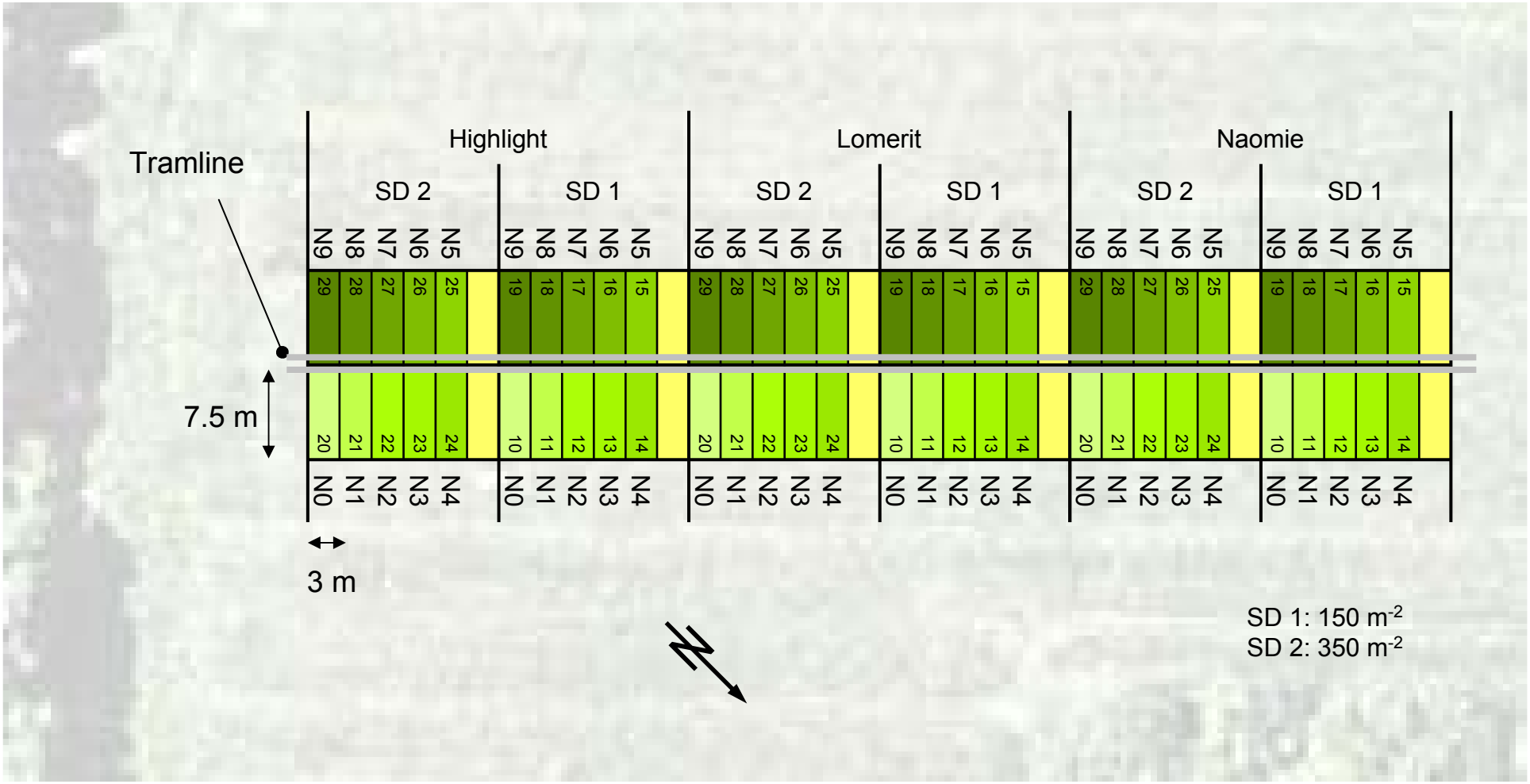
➔ Variable rate N fertilization should be based on accurate measurements of N uptake

Agronomic calibration of the sensor reading

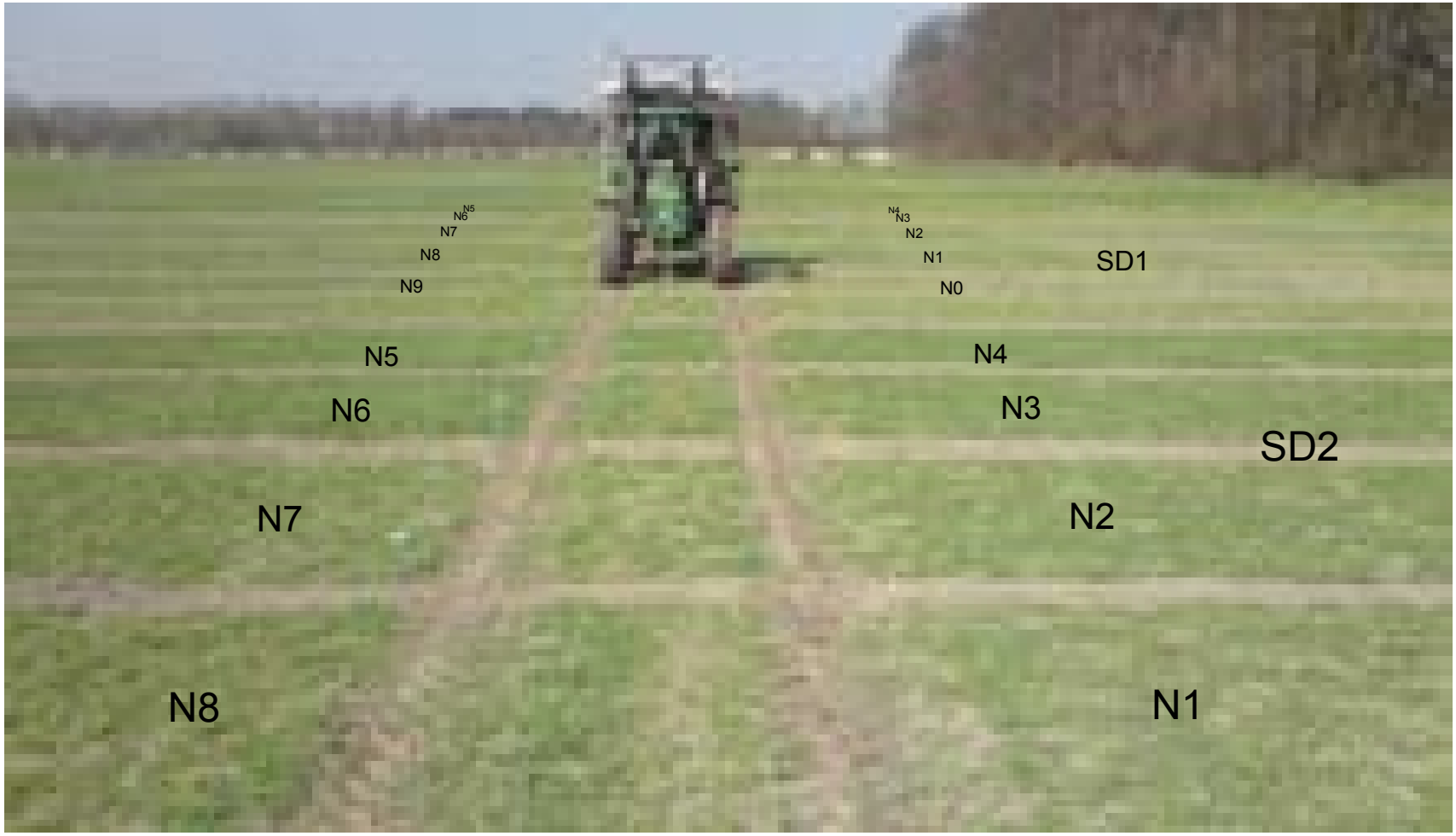
Relationship sensor reading/crop parameter → sensor value

Foto: www.luftbild-auto.de

Calibration trial winter barley 2009

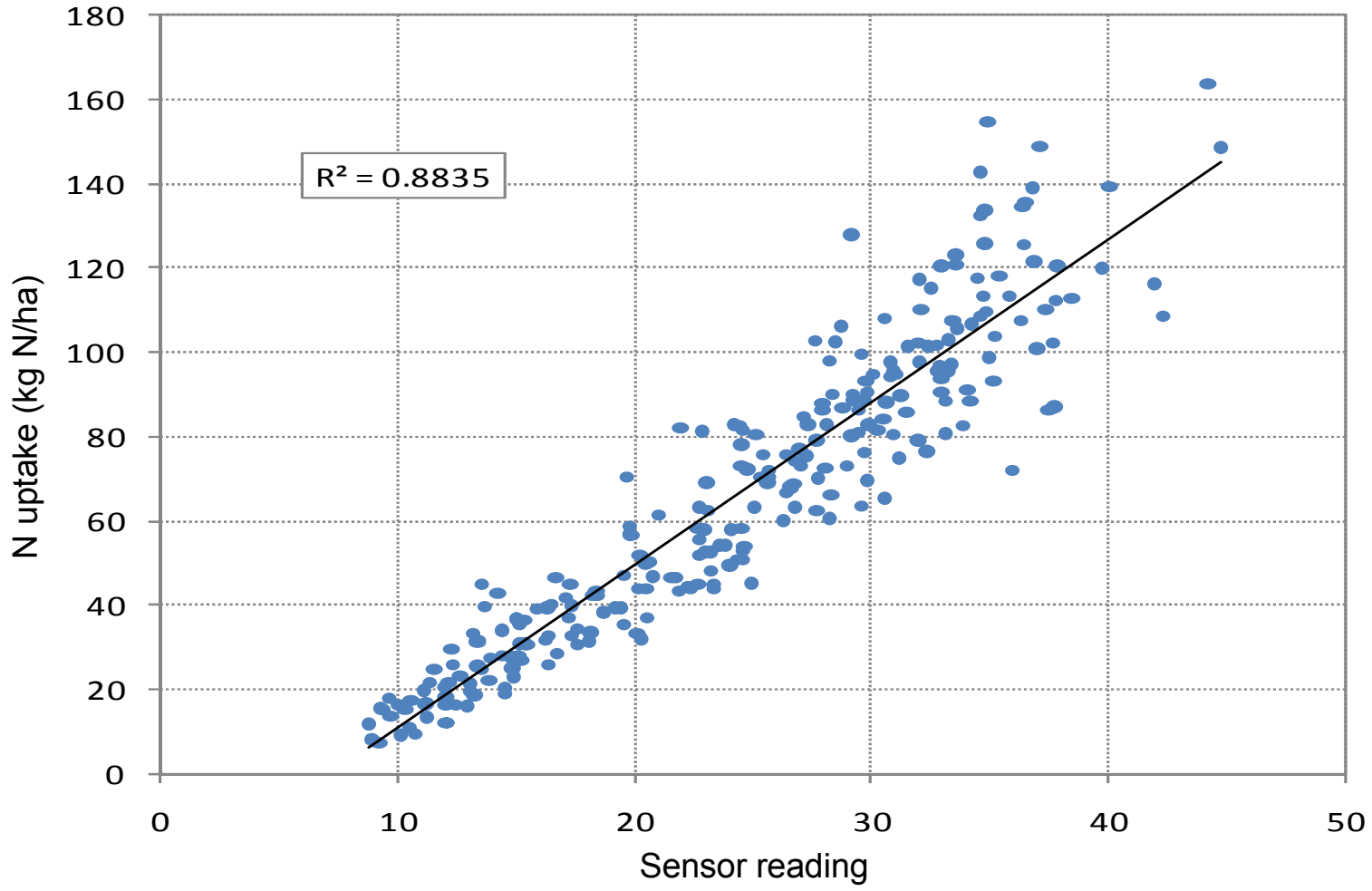


Calibration trial winter barley 2009



Sensor measurements and plant sampling

N-Sensor reading calibrated for N uptake

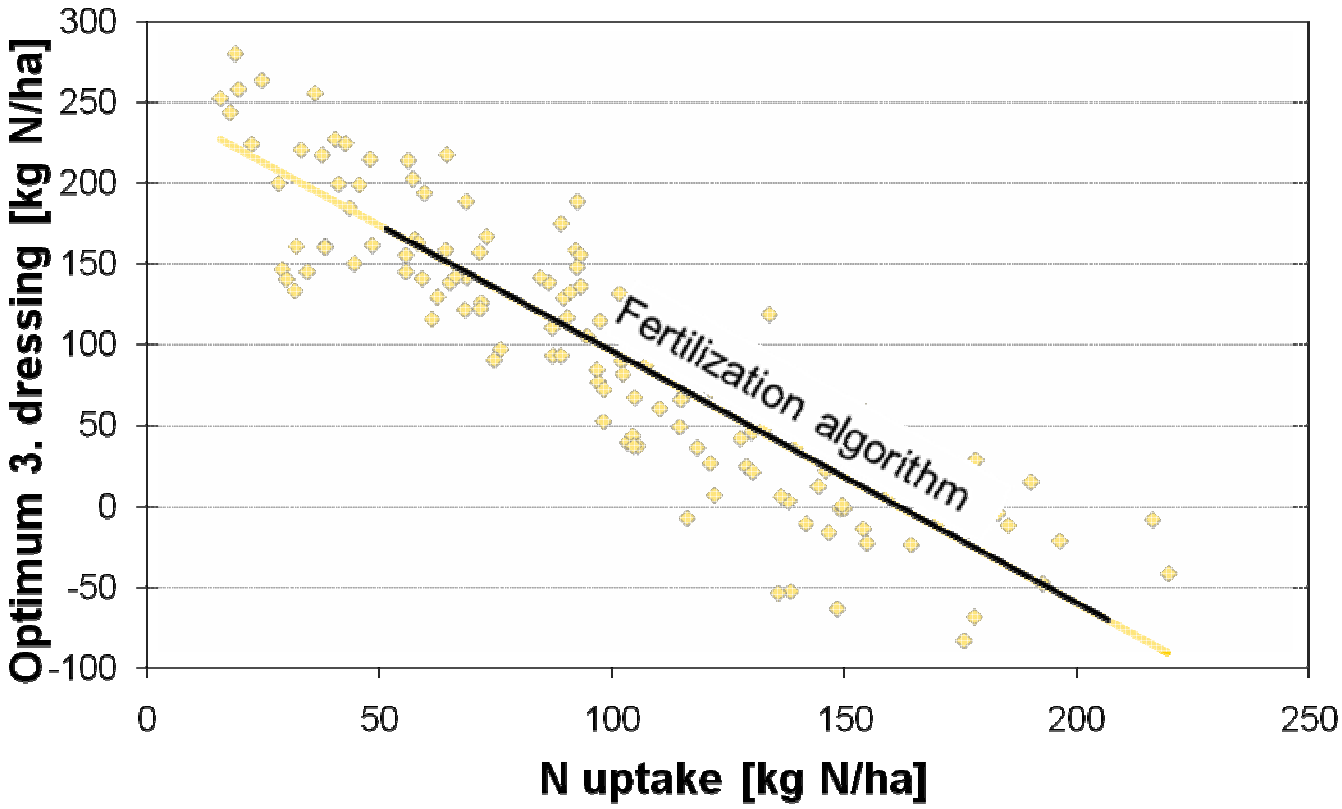


Fertilization algorithms

Decision rules for variable rate N application

Foto: www.luftbild-auto.de

Measurement of N uptake is the basis for the agronomic calibration of the N-Sensor



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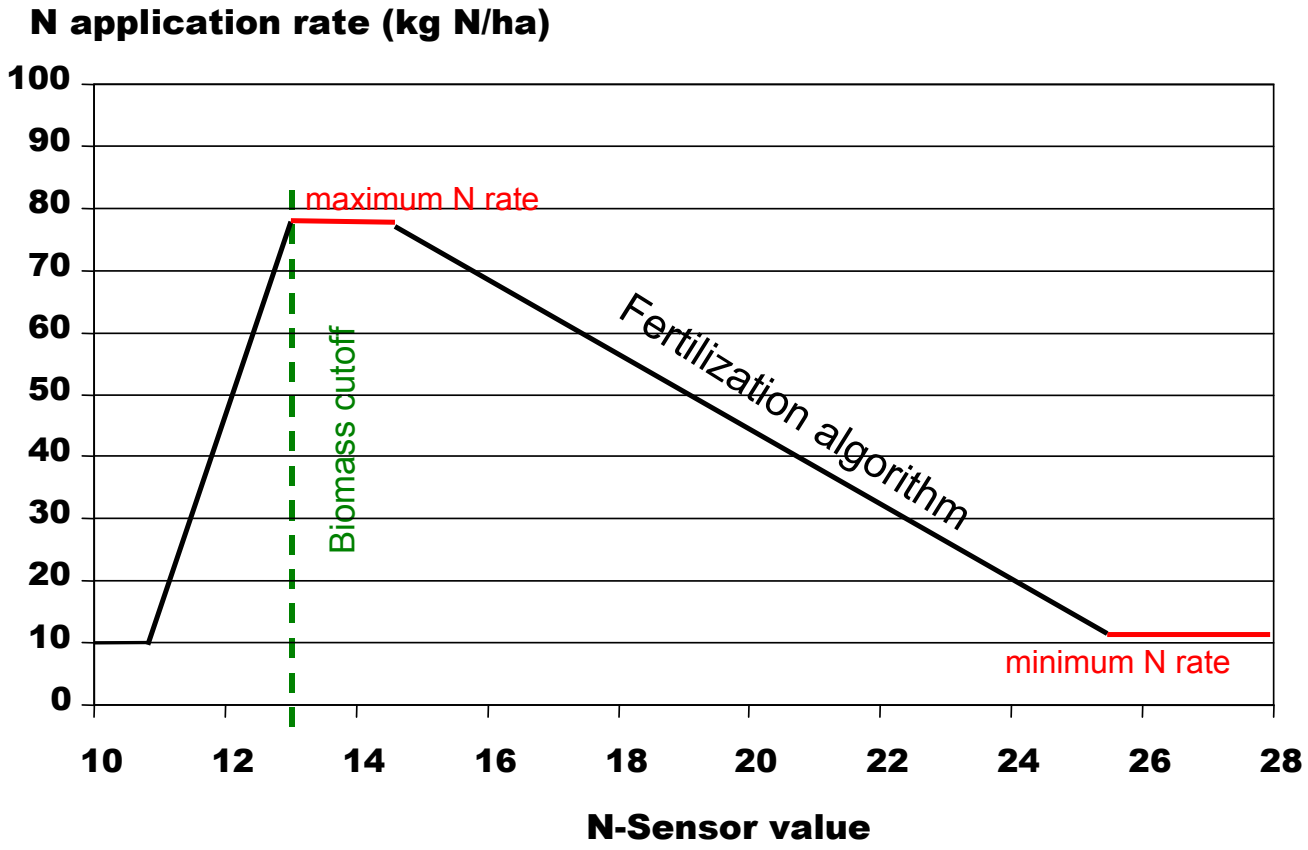


N-Sensor fertilization algorithms are available for:

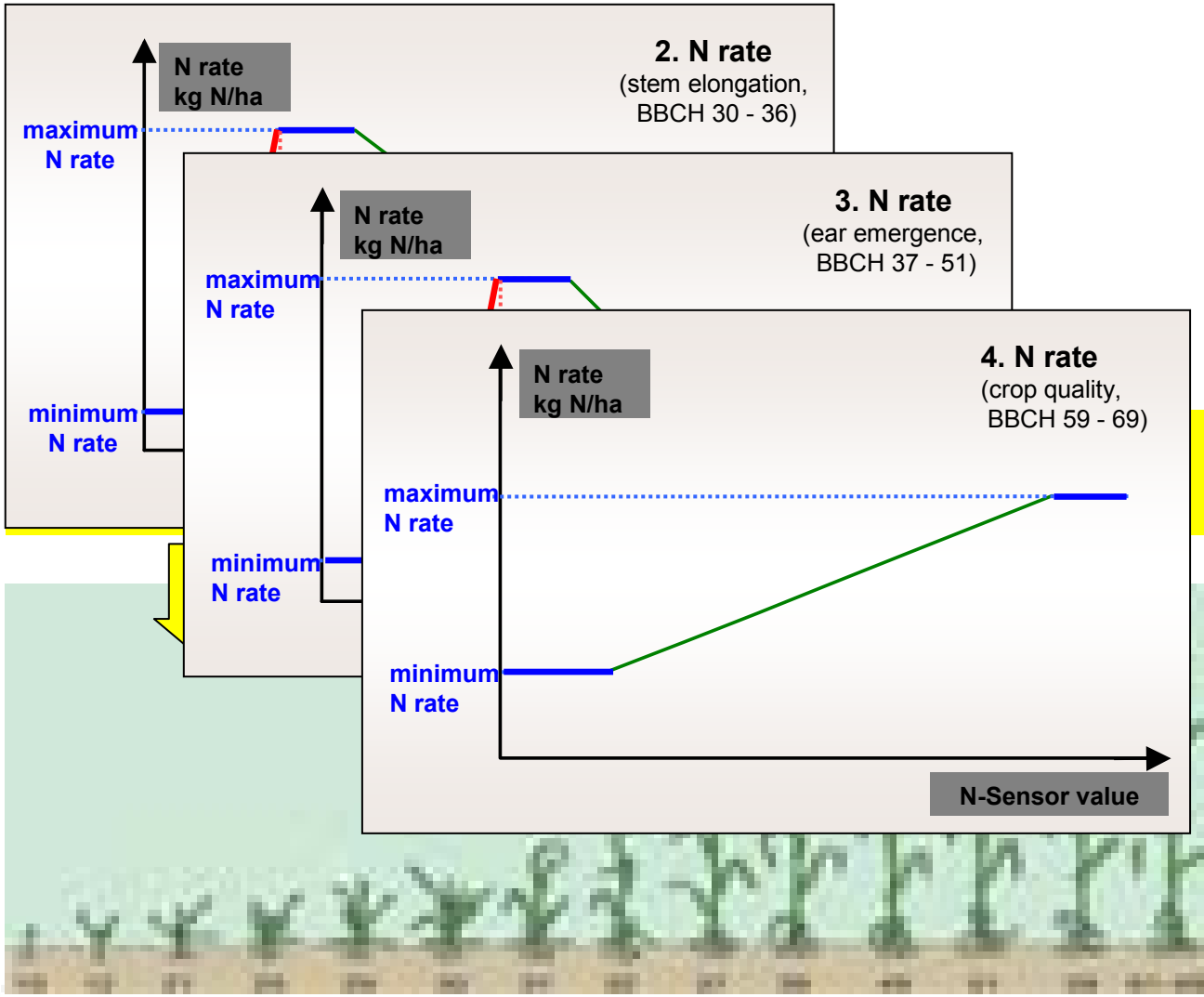
Winter wheat
Winter barley
Winter rye
Triticale
Spring barley
Oat

Corn

Winter oilseed rape

Potato

Fertilization algorithms for winter cereals



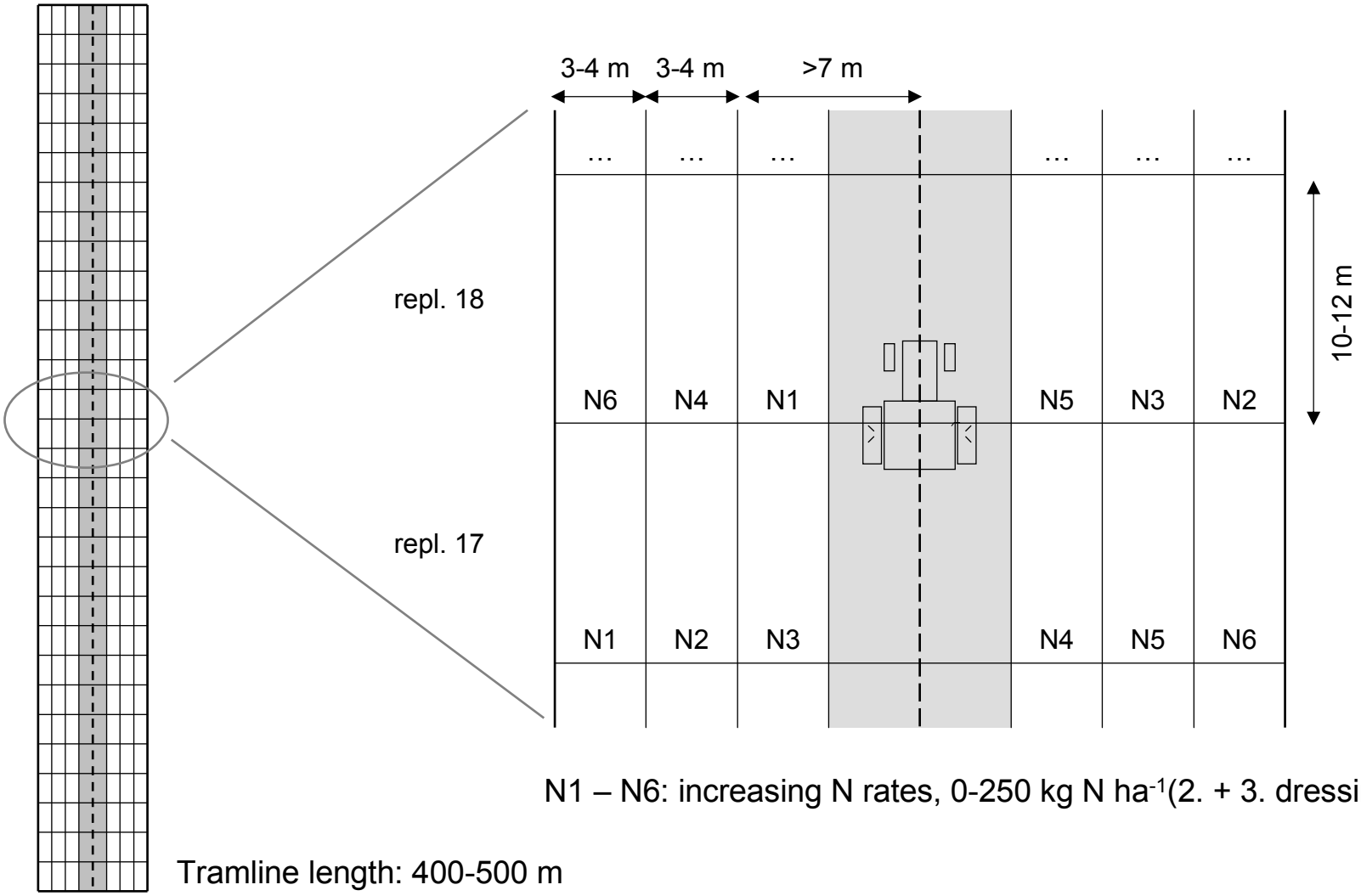
site-specific
N application

Variable rate N fertilization

Calibration and decision rules are determining the success

Foto: www.luftbild-auto.de

Multiple N response trials along a tramline - site-specific N production functions

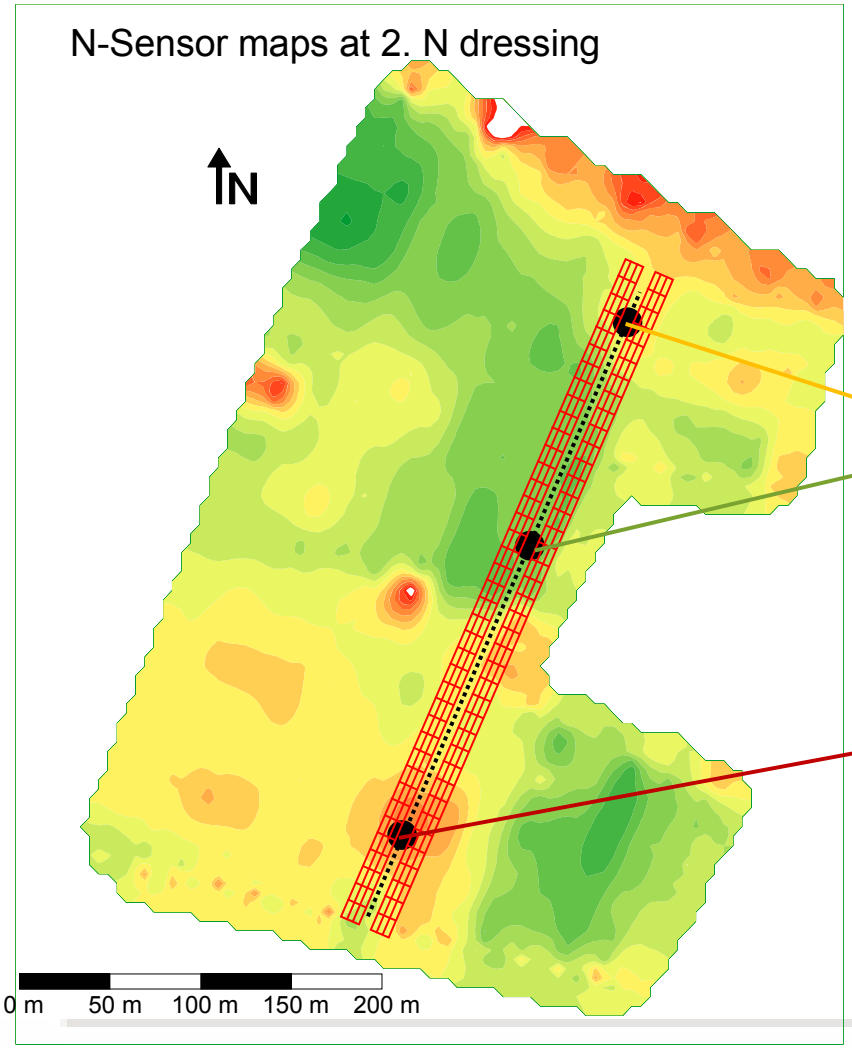


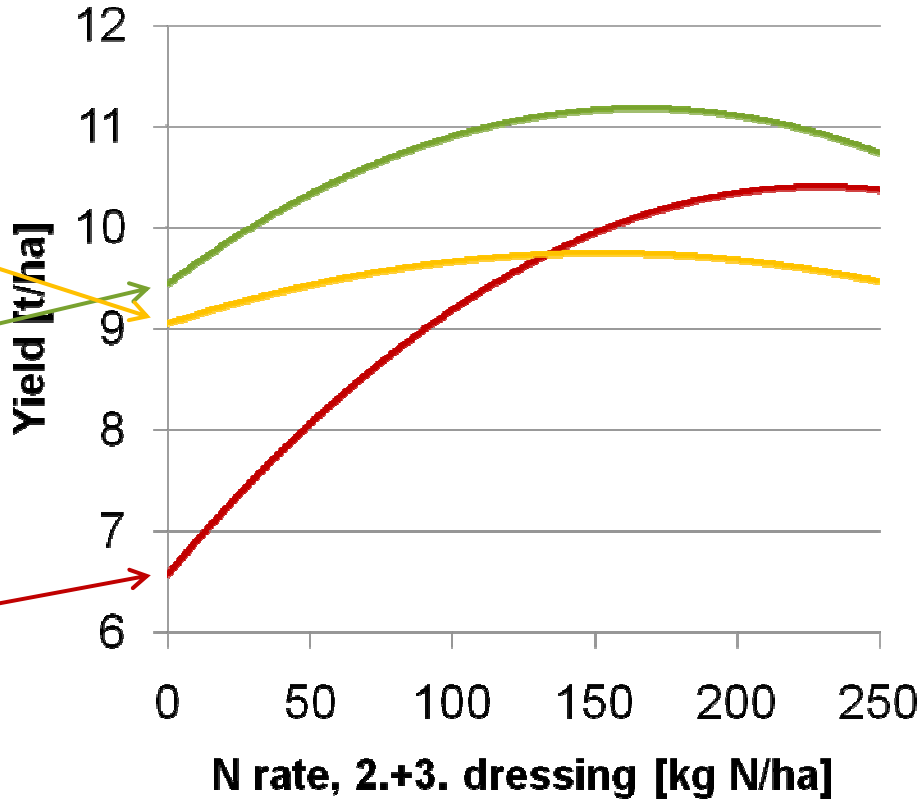
N1 – N6: increasing N rates, 0-250 kg N ha^{-1}(2. + 3. dressing)

Tramline length: 400-500 m

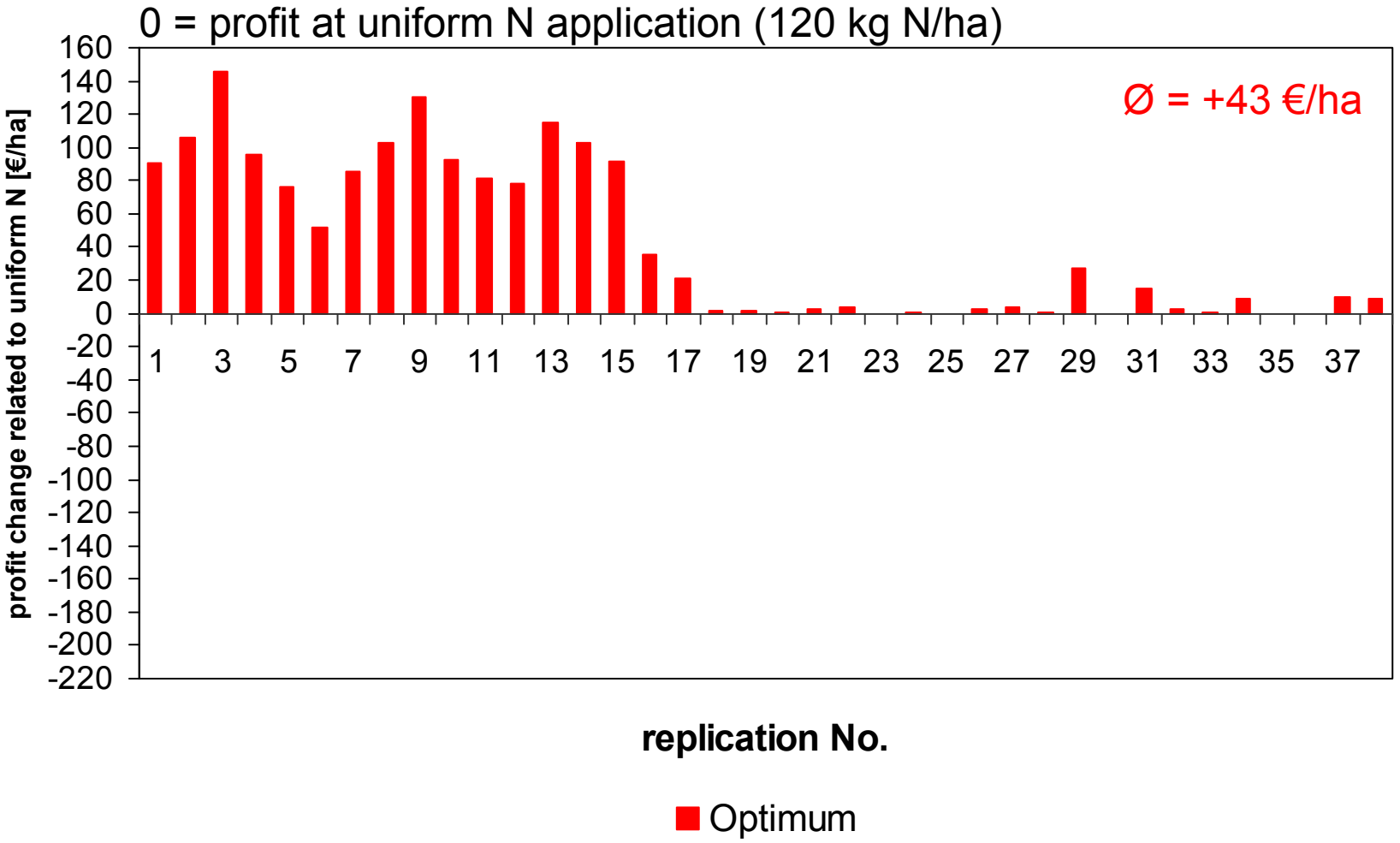
N response trial along a tramline
Winter wheat 2003/2004

N response trial along a tramline
Winter wheat 2003/2004

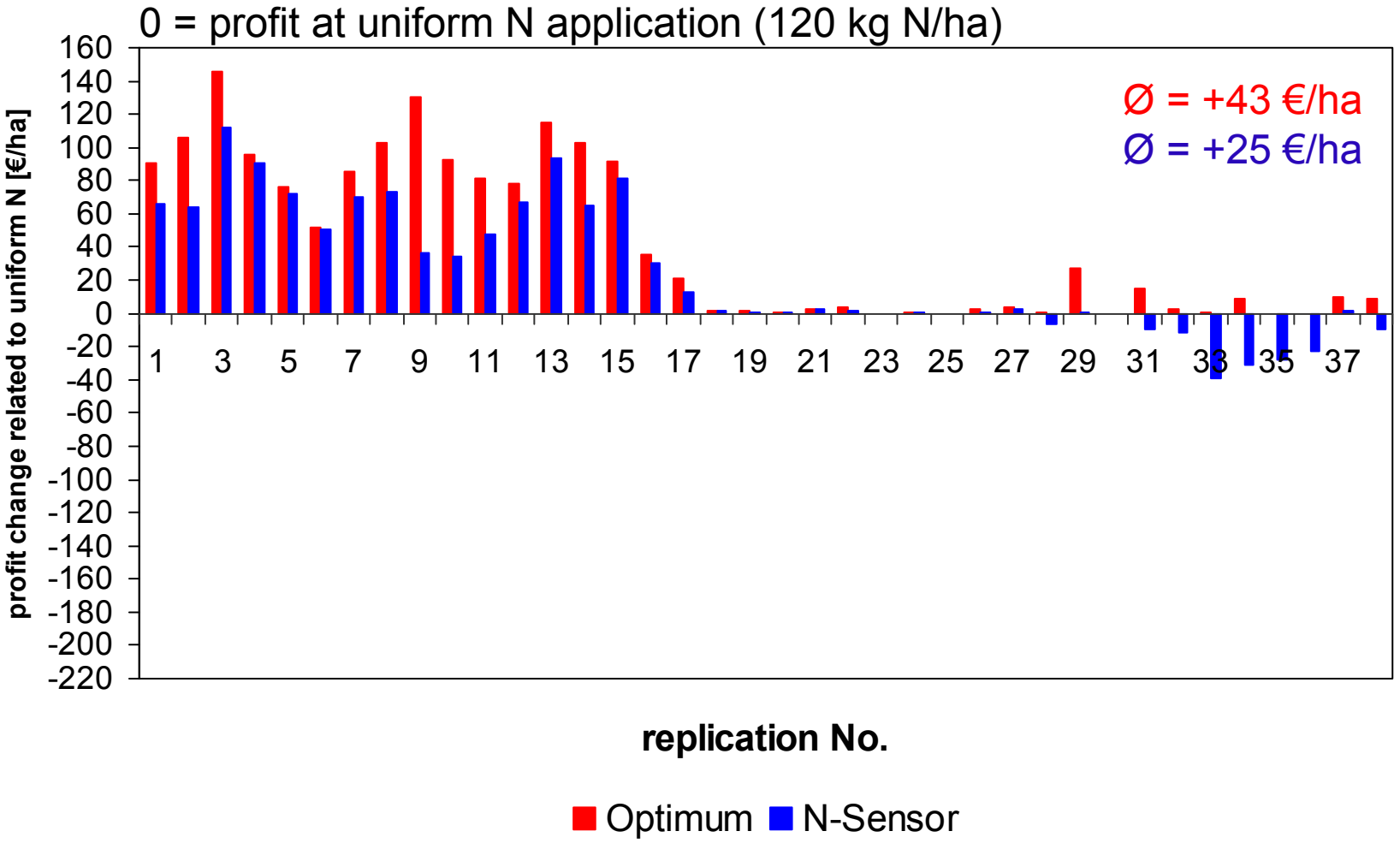




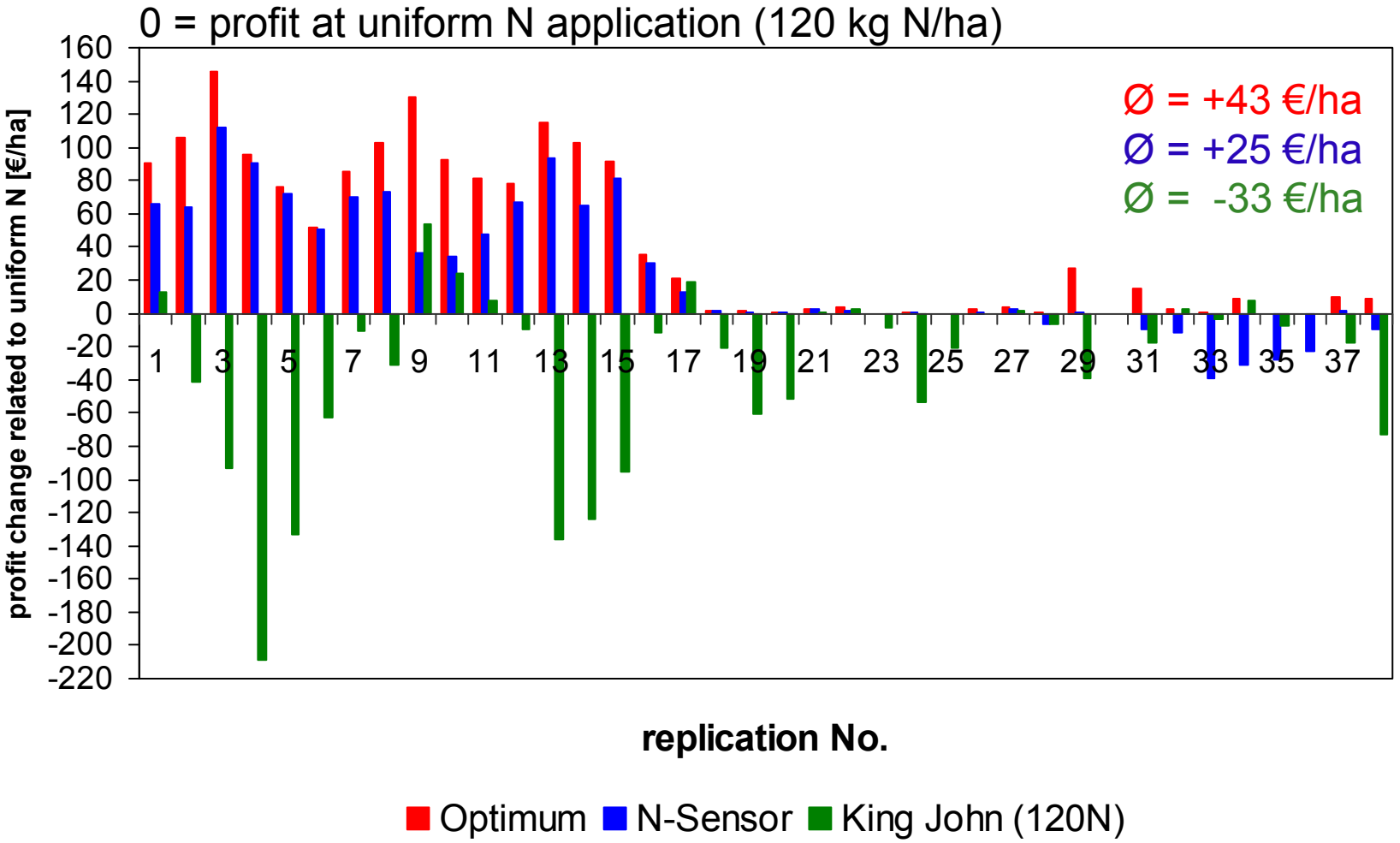
The agronomic concept determines the success
Optimum VRN compared to uniform N (120 kg N/ha)



The agronomic concept determines the success N-Sensor compared to uniform N (120 kg N/ha)



The agronomic concept determines the success N-Sensor compared to uniform N (120 kg N/ha)



Summary

- Variable rate N fertilization is an agronomic concept.
- In order to make the concept work in farm practice, accurate and reliable crop canopy sensors are needed.
- Readings of such sensors need to be calibrated in field trials in order to get meaningful information about the crop, i.e. from an agronomic point of view.
- The economic success of variable rate N fertilization depends on the decision rules applied to derive site-specific N recommendations from the measured differences of crop properties.
- The N-Sensor is the only system for variable rate N fertilization that combines high performance sensor technology with site-specific fertilization algorithms that have been developed and verified in field trials.

Thank you very much!

Questions?